Appendix D – Geotechnical Study Report

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GEOTECHNICAL STUDY REPORT

SPRING LAKE VILLAGE EAST GROVE
HIGHWAY 12 AND LOS ALAMOS ROAD
SANTA ROSA, CALIFORNIA

Project Number:

2411.05.05.1

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INTRODUCTION

This report presents the results of our geotechnical study for the proposed Spring Lake Village East Grove to be constructed at the southwest corner of Highway 12 and Los Alamos Road in Santa Rosa, California. The project site is generally L-shaped with a portion parallel to Highway 12 that is undeveloped and slopes gently from east to west. This portion is covered with seasonal grasses and weeds with scattered mature trees and was the original extent of the East Grove project. We performed a geotechnical study for this portion of the project and presented the results in a report dated January 6, 2015. A second portion of the property was added to the project and is relatively level and extends off Melita Road. This portion of the property contains at least two residential structures with associated outbuildings, a swimming pool and asphalt paved driveways. The site location is shown on Plate 1, Appendix A.

We understand it is proposed to construct 12 main structures within the East Grove project. The structures will include one villa, ten cottages and one common building. The villa and cottages will be similar to those constructed on the western parcel of the main facility. The project plan we reviewed included two smaller support structures as well. Retaining walls may be needed to provide level breaks across the property. Auto access will be provided by a driveway off Los Alamos Road and driveways throughout the facility with parking provided at each cottage and at the villa and common building. Sidewalks are planned throughout the planned facility.

Foundation loads are expected to be typical of the light to moderately heavy type of construction proposed. We anticipate wall loads will range from 1 to 5 kips per lineal foot. We understand site grading will be the minimum needed to construct level building pads and paved areas with positive drainage. Such grading could include cuts and fills of about 1 to 4 feet.

Utility plans are not available, but we have assumed that the project utilities will extend no deeper than 10 feet below the existing ground surface. If project utilities extend deeper, supplemental exploration may be required to evaluate the soil conditions within and below the utility excavations.

SCOPE

The purpose of our study, as outlined in our Professional Service Agreement dated October 21, 2014, and our Request for Authorization of Additional Services letter dated January 16, 2017, was to generate geotechnical information for the design and construction of the project. Our scope of services included reviewing selected published geologic data pertinent to the site; evaluating subsurface conditions with borings and laboratory tests; analyzing the field and laboratory data; and presenting this report with the following geotechnical information:

1. A brief description of soil and groundwater conditions observed during our study;

2. A discussion of seismic hazards that may affect the proposed development; and

3. Conclusions and recommendations regarding:

    a. Primary geotechnical engineering concerns and mitigating measures, as applicable;

    b. Site preparation and grading including remedial grading of weak, porous, compressible and/or expansive surface soils;

c. Foundation type(s), design criteria and estimated settlement behavior;

d. Lateral loads for retaining wall design;

e. Support of concrete slabs-on-grade;

f. Preliminary pavement thickness based on our experience with similar soils and projects;

g. Utility trench backfill;

h. Geotechnical engineering drainage improvements; and

i. Supplemental geotechnical engineering services.

STUDY

Site Exploration

We reviewed our previous geotechnical studies in the vicinity and selected geologic references pertinent to the site. The geologic literature reviewed is listed in Appendix B.

On December 12 and 13, 2014, we performed a geotechnical reconnaissance of the site and explored the subsurface conditions by drilling nine borings to depths ranging from about 16½ to 21½ feet. On January 24, 2017, we drilled four additional borings in the added site area to depths ranging from 4½ to 15½ feet. The borings were drilled with a track-mounted drill rig equipped with both 4-inch diameter, solid stem augers and 8-inch diameter, hollow stem augers, at the approximate locations shown on the Exploration Plan, Plate 2. The boring locations were determined approximately by pacing their distance from features shown on the Exploration Plan and should be considered accurate only to the degree implied by the method used. Our field engineer located and logged the borings and obtained samples of the materials encountered for visual examination, classification and laboratory testing.

Relatively undisturbed samples were obtained from the borings at selected intervals by driving a 2.43-inch inside diameter, split spoon sampler, containing 6-inch long brass liners, using a 140-pound hammer dropping approximately 30 inches. The sampler was driven 12 to 18 inches, or to refusal. The blows required to drive each 6-inch increment were recorded and the blows required to drive the last 12 inches, or portion thereof, were converted to equivalent Standard Penetration Test (SPT) blow counts for correlation with empirical data. Disturbed samples were also obtained at selected depths by driving a 1.375-inch inside diameter (2-inch outside diameter) SPT sampler, without liners or rings, using a 140-pound hammer dropping approximately 30 inches. The sampler was driven 12 to 18 inches, the blows to drive each 6-inch increment were recorded, and the blows required to drive the final 12 inches, or portion thereof, are provided on the boring logs. Disturbed "bulk" samples of the anticipated subgrade soils were also obtained and placed in buckets.

The logs of the borings showing the materials encountered, groundwater conditions, converted blow counts and sample depths are presented on Plates 3 through 15. The soils are described in accordance with the Unified Soil Classification System, outlined on Plate 16.

The boring logs show our interpretation of subsurface soil and groundwater conditions on the date and at the locations indicated. Subsurface conditions may vary at other locations and times. Our interpretation is based on visual inspection of soil samples, laboratory test results, and interpretation of drilling and sampling resistance. The location of the soil boundaries should be considered approximate. The transition between soil types may be gradual.

Laboratory Testing

The samples obtained from the borings were transported to our office and re-examined to verify soil classifications, evaluate characteristics, and assign tests pertinent to our analysis. Selected samples were laboratory tested to determine their water content, dry density, classification (Atterberg Limits, percent of silt and clay), unconfined compressive strength and expansion potential (Expansion Index - EI). The test results are presented on the boring logs. Results of the classification and unconfined compression strength tests are presented on Plates 17 through 20.

SITE CONDITIONS

General

Sonoma County is located within the California Coast Range geomorphic province. This province is a geologically complex and seismically active region characterized by sub-parallel northwest-trending faults, mountain ranges and valleys. The oldest bedrock units are the Jurassic-Cretaceous Franciscan Complex and Great Valley sequence sediments originally deposited in a marine environment. Subsequently, younger rocks such as the Tertiary-age Sonoma Volcanics group, the Plio-Pleistocene-age Clear Lake Volcanics and sedimentary rocks such as the Guinda, Domengine, Petaluma, Wilson Grove, Cache, Huichica and Glen Ellen formations were deposited throughout the province. Extensive folding and thrust faulting during late Cretaceous through early Tertiary geologic time created complex geologic conditions that underlie the highly varied topography of today. In valleys, the bedrock is covered by thick alluvial soils.

Geology

Published geologic maps (McLaughlin et al., 2008) indicate the property is predominantly underlain by Holocene and Pleistocene alluvial deposits, undivided (Qt), which includes undivided Holocene and Pleistocene terrace deposits. According to McLaughlin et al. (2008), the northeastern portion of the property is underlain by Pliocene fluvial and lacustrine deposits of Humbug Creek (Tgp). These deposits consist of gravel, sandstone, siltstone, mudstone, nonmarine diatomite and locally mapped intercalated siliceous tuff (Tst). In the project area this unit consists largely of boulder, cobble and pebble gravel, and sand and silt derived from underlying Mesozoic rocks and from Tertiary volcanic rocks.

Landslides

Published landslide maps (Huffman and Armstrong, 1980, and Dwyer, 1976) do not indicate large-scale slope instability at the site, and we did not observe active landslides at the site during our study.

Surface

The undeveloped portion of the site slopes gently from east to west and is covered with seasonal grasses and weeds with scattered mature trees. The developed portion of the site is relatively flat and contains at least two residential structures with associated outbuildings, a swimming pool and asphalt paved driveways. In general, the ground surface is soft and spongy. This is a condition generally associated with weak, porous surface soils. Natural drainage consists of sheet flow over the ground surface that concentrates in man-made surface drainage elements such as roadside ditches, canals and gutters, and natural drainage elements such as swales and creeks.

Subsurface

Our borings and laboratory tests indicate that the portion of the site we studied is generally blanketed by 2 to 3 feet of weak, porous, compressible and expansive clayey soils. Porous soils appear hard and strong when dry but become weak and compressible as their moisture content increases towards saturation. These soils exhibit low to high plasticity (LL = 27-71; PI = 9-53) and moderate to very high expansion potential (EI = 43-153). These surface materials are underlain by medium dense to very dense sand and gravel with varying amounts of clay with occasional layers of clay with varying amounts of sand and gravel.

A detailed description of subsurface conditions found in our borings is given on Plates 3 through 15, Appendix A. Based on Table 20.3-1 of American Society of Civil Engineers (ASCE) Standard 7-10, titled “Minimum Design Loads for Buildings and Other Structures” (2010), we have determined a Site Class of D should be used for the site.

Corrosion Potential

Mapping by the Natural Resources Conservation Service (2017) indicates that the corrosion potential of the near surface soil is moderate for uncoated steel and moderate for concrete. Performing corrosivity tests to verify these values was not part of our requested and/or proposed scope of work. Should the need arise, we would be pleased to provide a proposal to evaluate these characteristics.

Groundwater

Free groundwater was first detected in borings B-1 through B-5 and B-10 through B-13 at depths ranging from 1 to 4 feet below the ground surface at the time of drilling. When the holes were backfilled at the end of the day, the water level had risen to depths ranging from about ½ to 2½ feet. These groundwater levels were measured in B-1 through B-5 shortly after heavy rainstorms and in B-10 through B-13 after extended periods of heavy rain. These values are not likely indicative of the normal groundwater levels at the site, but are indicative with how high groundwater can get at the site. Groundwater was not detected in borings B-6 through B-9. Fluctuation in the groundwater level typically occurs because of a variation in rainfall intensity, duration and other factors such as flooding and periodic irrigation.

DISCUSSION AND CONCLUSIONS

Seismic Hazards

Seismicity

Data presented by the Working Group on California Earthquake Probabilities (2007) estimates the chance of one or more large earthquakes (Magnitude 6.7 or greater) in the San Francisco Bay region within the next 30 years to be approximately 63 percent. Therefore, future seismic shaking should be anticipated at the site. It will be necessary to design and construct the proposed structures in strict adherence with current standards for earthquake-resistant construction.

Faulting

We did not observe landforms within the area that would indicate the presence of active faults and the site is not within a current Alquist-Priolo Earthquake Fault Zone (Bryant and Hart, 2007). Therefore, we believe the risk of fault rupture at the site is low. However, the site is within an area affected by strong seismic activity. Several northwest-trending Earthquake Fault Zones exist in close proximity to and within several miles of the site (Bortugno, 1982). The shortest distances from the site to the mapped surface expression of these faults are presented in the table below.

ACTIVE FAULT PROXIMITY		
Fault	**Direction**	**Distance-Miles**
San Andreas	SW	23
Healdsburg-Rodgers Creek	SW	3
Concord-Green Valley	ESE	26
Cordelia	ESE	28
West Napa	ESE	16
Maacama	NNW	10
Hunting Creek	NNW	26

Liquefaction

Liquefaction is a rapid loss of shear strength experienced in saturated, predominantly granular soils below the groundwater level during strong earthquake ground shaking due to an increase in pore water pressure. The occurrence of this phenomenon is dependent on many complex factors including the intensity and duration of ground shaking, particle size distribution and density of the soil.

Granular soils were encountered at the site below the groundwater table. Therefore, we performed an analysis of the blow count data from our borings using the methods of Seed and Idriss (1982), Seed and others (1985), Youd and Idriss (2001), Idriss and Boulanger (2004) and Idriss and Boulanger (2008). These procedures normalize the blow counts to account for overburden pressure, rod length, hammer energy, and fines (percent of silt and clay) content. Once the blow counts are normalized and adjusted to a clean sand blow count, the cyclic resistance ratio (CRR) for each blow count is then determined using the same procedures referenced above. The CRR is compared to the cyclic stress ratio (CSR) induced by the earthquake. Calculating the CSR requires a peak ground acceleration and design earthquake magnitude.

Peak ground acceleration (PGA) was determined using the methods in the 2016 California Building Code (CBC) and the American Society of Civil Engineers (ASCE) Standard 7-10 (ASCE, 2010). Using the U.S. Seismic Design Maps from the United States Geological Survey (USGS) website (http://earthquake.usgs.gov/designmaps/us/application.php), the site's latitude and longitude of 38.4581°N and 122.6364°W, respectively, and a site soil Class of D, the PGA for the site is 0.68g. Using this information, the CSR for a M_M 7.5 earthquake at the site ranges from 0.42 to 0.82. The Rodgers Creek fault is most likely controlling the ground motions at the site. According to Petersen (1996), the Rodgers Creek fault is capable of a M_M 7.0 earthquake. Therefore, the CRR values at the site must be scaled to account for the difference between M_M 7.0 and M_M 7.5. When the scaling factor for magnitude and confining stress corrections presented in Idriss and Boulanger (2004) are applied, the CRR values at the site generally exceed the CSR values. Our analysis did encounter layers with moderate potential for liquefaction from 1½ to 3 feet in boring B-1, 1 to 3 feet in boring B-3, 2 to 3½ feet in boring B-4, 1 to 2½ feet in boring B-7, 9 to 12 feet in boring B-8, 0 to 3 feet and 5 to 8 feet in B-10, and 8 to 13 feet in B-13. Provided remedial grading is performed as recommended herein, the potential for liquefaction of the layers in borings B-1, B-3, B-4, B-7 and from 0 to 3 feet in boring B-10 will be reduced to negligible. Therefore, the only remaining susceptible layers we encountered were in borings B-8, B-10, and B-13.

There are three potential consequences of liquefaction: bearing capacity failure, lateral spreading toward a free face (e.g. riverbank) and settlement. Bearing capacity failure is sudden and extreme settlement of foundations that typically occurs when the liquefied layer is relatively close (typically within two times the footing width, depending on the loads) to the bottom of the foundation. Because the liquefiable layer in borings B-8 and B-13 are about 8 to 9 feet below the ground surface, we judge that the potential for bearing capacity failure is low in the area of these borings is low. The potentially liquefiable layer in boring B-10 is at about 5 feet below the ground surface. This layer is close enough to potential foundations that the cottages in this area need to be supported on stiffened foundation systems such as post-tensioned slabs-on-grade. This condition should be assumed for the structures in the area of borings B-10 and B-12 as delineated on Plate 2.

Lateral spreading can occur where continuous layers of liquefiable soil extend to a free face, such as a creek bank. The potentially liquefiable layer at the site is discontinuous. Therefore, we judge the potential for liquefaction-induced lateral spreading at the site is low.

The third potential consequence of liquefaction is settlement due to densification of the liquefied soils. Potential settlement based on the blow count data and cyclic stress ratio was calculated using the methods of Ishihara and Yoshimine (1992). For the layer encountered in boring B-8 from 9 to 12 feet below the surface, we calculated total settlement of up to 0.43 inches. For the layer encountered in boring B-10 from 5 to 8 feet below the surface, we calculated total settlement of up to 0.74 inches. For the layer encountered in boring B-13 from 8 to 13 feet below the surface, we calculated total settlement of up to 1¼ inches. Based on the above information, we estimate that differential settlement in the original planned project area could range up to ½-inch. Differential settlement in the added portion of the project could range from up to 1¼ inches. Therefore, structures within the area encompassed by borings B-10, B-11, B-12 and B-13 need to be designed for this higher level of differential settlement. This area is delineated on Plate 2.

Densification

Densification is the settlement of loose, granular soils above the groundwater level due to earthquake shaking. Provided remedial grading is performed as recommended herein, we judge that there is a low potential for densification to impact structures at the site.

Geotechnical Issues

General

Based on our study, we judge the proposed Spring Lake Village East Grove can be built as planned, provided the recommendations presented in this report are incorporated into its design and construction. The primary geotechnical concerns during design and construction of the project are:

1. The presence of 2 to 3 feet of moderate to highly expansive, weak, porous, compressible, clayey surface soils;

2. The potential for liquefaction at the site;

3. The de-stabilizing effect of uncontrolled surface runoff and the potential for high groundwater; and

4. The strong ground shaking predicted to impact the site during the life of the project.

Weak, Porous Surface Soils

Weak, porous surface soils, such as those found at the site, appear hard and strong when dry but will lose strength rapidly and settle under the load of fills, foundations, slabs, and pavements as their moisture content increases and approaches saturation. The moisture content of these soils can increase as the result of rainfall, periodic irrigation or when the natural upward migration of water vapor through the soils is impeded by, and condenses under fills, foundations, slabs, and pavements. The detrimental effects of such movements can be reduced by strengthening the soils during grading. This can be achieved by excavating the weak soils and replacing them as properly compacted (engineered) fill.

Expansive Soil - In addition, the surface soils are expansive. Expansive surface soils shrink and swell as they lose and gain moisture throughout the yearly weather cycle. Near the surface, the resulting movements can heave and crack lightly loaded shallow foundations (spread footings) and slabs and pavements. The zone of significant moisture variation (active layer) is dependent on the expansion potential of the soil and the extent of the dry season. In the building areas, the active layer is generally considered to range in thickness from about 2 to 3 feet. The detrimental effects of the above-described movements can be reduced by pre-swelling the expansive soils and covering them with a moisture fixing and confining blanket of properly compacted select fill, as subsequently defined. In building areas, the blanket thickness required depends on the expansion potential of the soils and the anticipated performance of the foundations and slabs. In order to effectively reduce foundation and slab heave given the expansion potential of the site's soils, a blanket thickness of 30 inches will be needed. In exterior slab and paved areas, the select fill blanket need only be 12 inches thick. Alternatively, the structures can be founded on post-tensioned slabs-on-grade. Post-tensioned slabs-on-grade are required for the structures within the shallow liquefiable soil zone shown on Plate 2.

Liquefiable Soils

As discussed previously, potentially liquefiable soils were encountered at the site. The potential consequences of liquefaction at this site are bearing capacity failure where the liquefiable soils are shallow and differential settlement. The impacts of bearing failure can be reduced by the remedial grading recommended herein and using a stiffened foundation such as a post-tensioned slab-on-grade. The area where shallow liquefiable soils are present is delineated on Plate 2. Liquefaction-induced differential settlement will, in general, be on the order of ½-inch across each building. However, within the area delineated on Plate 2, differential settlement across each building will be on the order of 1¼ inches.

Foundation and Slab Support - Provided grading is performed as discussed above, satisfactory foundation support, except as noted for the shallow liquefiable soil area on Plate 2, can be obtained from spread footings that bottom on the select engineered fill at least 12 inches below pad subgrade. Interior slab-on-grade floors can also be satisfactorily supported on the select engineered fill. As an alternative to select fill, the structures can be supported on post-tensioned slabs-on-grade provided the weak, porous surface soils are removed and replaced as engineered fill. Post-tensioned slabs-on-grade are required for the structures within the shallow liquefiable soil zone shown on Plate 2. In addition, site walls and site retaining walls can be supported on spread footings that gain support in firm, native soils.

Exterior Slabs and Pavements

Exterior slabs and pavements will heave and crack as the expansive soils shrink and swell through the yearly weather cycle. Slab and pavement cracking and distress are typically concentrated along edges where moisture content variation is more prevalent within subgrade soils. Slab and pavement performance and the incidence of repair can be reduced, but not eliminated, by covering the pre-swelled expansive soils with at least 12 inches of select fill (see "On-Site Soil Quality" section) prior to constructing the slab or pavement required to carry the anticipated traffic.

On-Site Soil Quality

All fill materials used in the upper 30 inches of the building areas, where spread footings are chosen for foundation support, and the upper 12 inches of exterior slab and pavement subgrade must be select, as subsequently described in "Recommendations." We anticipate that, with the exception of organic matter and of rocks or lumps larger than 6 inches in diameter, the excavated material will be suitable for re-use as general fill, but will not be suitable for use as select fill unless stabilized with lime.

Select Fill

The select fill can consist of approved on-site soils or import materials with a low expansion potential or lime stabilized on-site clayey soils. Lime stabilized soils may prevent the growth of landscape vegetation due to the inherent elevated pH level of the soil. The geotechnical engineer must approve the use of on-site soils as select fill during grading.

Settlement

If remedial grading is performed and the spread footings are installed in accordance with the recommendations presented in this report, we estimate that post-construction differential settlements across the buildings will be about ½ inch. Liquefaction-induced settlement in the area delineated on Plate 2 could be on the order of 1¼ inches across each building. In the remaining area of the site, liquefaction-induced differential settlement will be on the order of ½-inch across each building.

Surface Drainage

Because of topography and location, the site will be impacted by surface runoff from the up-gradient slopes. Surface runoff typically sheet flows over the ground surface but can be concentrated by the planned site grading, landscaping, and drainage. The surface runoff can pond against structures and cause deeper than normal soil heave and/or seep into the slab rock. Therefore, strict control of surface runoff is necessary to provide long-term satisfactory performance of projects constructed on or near hillsides. It will be necessary to divert surface runoff around improvements, provide positive drainage away from structures, and install energy dissipaters at discharge points of concentrated runoff. This can be achieved by constructing the building pad several inches above the surrounding area and conveying the runoff into man-made drainage elements or natural swales that lead down-gradient of the site.

Potentially High Groundwater

As previously discussed, the groundwater level at the site within borings B-1 through B-5, as well as B-10 through B-13 was within ½ to 2½ feet of the surface. These water levels were measured the day after the largest rainstorm of 2014, as well as after a period of several heavy rainstorms in 2017, and thus are not likely indicative of the normal groundwater levels at the site. It is also possible that this water may be perched on a denser layer below. Based on our observations it is possible that groundwater in the lower elevations of the site can rise from a few to several feet during prolonged periods of rainfall. Therefore, it should be anticipated that groundwater could impact excavations at the site during construction. Construction excavation dewatering and the sizing of the required dewatering system is typically the responsibility of the contractor.

RECOMMENDATIONS

Seismic Design

Seismic design parameters presented below are based on Section 1613 titled “Earthquake Loads” of the 2016 California Building Code (CBC). Based on Table 20.3-1 of American Society of Civil Engineers (ASCE) Standard 7-10 (ASCE, 2010), we have determined a Site Class of D should be used for the site. Using a site latitude and longitude of 38.4581 °N and -122.6364 °W, respectively, and the U.S. Seismic Design Maps from the United States Geological Survey (USGS) website (http://earthquake.usgs.gov/designmaps/us/application.php), we recommend that the following seismic design criteria be used for structures at the site.

2016 CBC Seismic Criteria	
Spectral Response Parameter	**Acceleration (g)**
S_S (0.2 second period)	1.764
S_1 (1 second period)	0.702
S_{MS} (0.2 second period)	1.764
S_{M1} (1 second period)	1.052
S_{DS} (0.2 second period)	1.176
S_{D1} (1 second period)	0.702

Grading

Site Preparation

Areas to be developed should be cleared of vegetation and debris. Trees and shrubs that will not be part of the proposed development should be removed and their primary root systems grubbed. Cleared and grubbed material should be removed from the site and disposed of in accordance with County Health Department guidelines. We did not observe septic tanks, leach lines or underground fuel tanks during our study. Any such appurtenances found during grading should be capped and sealed and/or excavated and removed from the site, respectively, in accordance with established guidelines and requirements of the County Health Department. Voids created during clearing should be backfilled with engineered fill as recommended herein.

Stripping

Areas to be graded should be stripped of the upper few inches of soil containing organic matter. Soil containing more than two percent by weight of organic matter should be considered organic. Actual stripping depth should be determined by a representative of the geotechnical engineer in the field at the time of stripping. The strippings should be removed from the site, or if suitable, stockpiled for re-use as topsoil in landscaping.

Excavation Dewatering

Groundwater was encountered within the planned excavation depth, including utility trenches. Therefore, in order to accomplish the planned grading, it may be necessary to dewater excavations. The dewatering system can consist of a perforated plastic pipe (in a grid array) embedded in free draining rock. The system should discharge to a sump area that is pumped continuously during construction. The general contractor is responsible for the design, operation and maintenance of the temporary dewatering system.

Excavations

Following initial site preparation, excavation should be performed as planned or recommended herein. Excavations extending below the proposed finished grade should be backfilled with suitable materials compacted to the requirements given below.

Within building areas and fill areas, the weak, porous, compressible surface soils should be excavated to within 6 inches of their entire depth, which is about 3 feet in our borings. Where spread footings are used for foundation support, additional excavation should be performed, as necessary, to allow space for the installation of a blanket of select fill, at least 30 inches thick, beneath the building pad subgrade. Select fill is not required in building areas where post-tensioned slab-on-grade foundations are used. The excavation of weak, compressible, expansive soils should also extend at least 12 inches below exterior slab and pavement subgrade to allow space for the installation of the select fill blanket discussed in the conclusions section of this report

The excavation of weak, porous, compressible, expansive surface materials should extend at least 5 feet beyond the outside edge of the exterior footings of the proposed buildings and 3 feet beyond the edge of exterior slabs and pavements and three feet beyond the toe of new fills. The excavated materials should be stockpiled for later use as compacted fill, or removed from the site, as applicable.

At all times, temporary construction excavations should conform to the regulations of the State of California, Department of Industrial Relations, Division of Industrial Safety or other stricter governing regulations. The stability of temporary cut slopes, such as those constructed during the installation of underground utilities, should be the responsibility of the contractor. Depending on the time of year when grading is performed, and the surface conditions exposed, temporary cut slopes may need to be excavated to 1½:1, or flatter. The tops of the temporary cut slopes should be rounded back to 2:1 in weak soil zones.

Subsurface Drainage

A subdrain should be installed where evidence of past or current seepage is observed. The subdrain should consist of a 4-inch diameter (minimum) perforated plastic pipe with SDR 35 or better embedded in Class 2 permeable material. The permeable material should be at least 12 inches thick and extend at least 12 inches above and below the seepage zone. We can provide input on where subdrains should be installed once a grading plan has been developed.

The depth and extent of subdrains should be determined and approved by the geotechnical engineer in the field during construction. In addition, subdrains should be installed at a minimum slope of 1 percent and should have cleanouts located at their ends and at turning points. “Sweep” type elbows and wyes should be used at all turning points and cleanouts, respectively. Subdrain outlets and riser cleanouts should be fabricated of the same material as the subdrain pipe as specified herein. Outlet and riser pipe fittings should not be perforated. A licensed land surveyor or civil engineer should provide “record drawings” depicting the locations of subdrains and cleanouts.

Fill Quality

All fill materials should be free of perishable matter and rocks or lumps over 6 inches in diameter, and must be approved by the geotechnical engineer prior to use. The upper 30 inches of fill beneath and within 5 feet of the building area, where spread footings and slab-on-grade floors are used, and the upper 12 inches of fill beneath and within 3 feet of exterior slabs and pavement edges should be select fill. We judge the on-site soils are generally suitable for use as general, but will not be suitable for use as select fill unless they are stabilized with lime. Lime stabilized soils may prevent the growth of landscape vegetation due to the inherent elevated pH level of the soil. The suitability of the on-site soils for use as select fill should be verified during grading.

Select Fill

Select fill should be free of organic matter, have a low expansion potential, and conform in general to the following requirements:

SIEVE SIZE	PERCENT PASSING (by dry weight)
6 inch	100
4 inch	90 – 100
No. 200	10 – 60

Liquid Limit – 40 Percent Maximum
Plasticity Index – 15 Percent Maximum
R-value – 20 Minimum (pavement areas only)

Expansive on-site soils may be used as select fill if they are stabilized with lime. In general, imported fill, if needed, should be select. Material not conforming to these requirements may be suitable for use as import fill; however, it shall be the contractor's responsibility to demonstrate that the proposed material will perform in an equivalent manner. The geotechnical engineer should approve imported materials prior to use as compacted fill. The grading contractor is responsible for submitting, at least 72 hours (3 days) in advance of its intended use, samples of the proposed import materials for laboratory testing and approval by the soils engineer.

Fill Placement

The surface exposed by stripping and removal of weak, compressible, expansive surface soils should be scarified to a depth of at least 6 inches, uniformly moisture-conditioned to at least 4 percent above optimum and compacted to at least 90 percent of the maximum dry density of the materials as determined by ASTM Test Method D-1557. In expansive soil areas, moisture conditioning should be sufficient to completely close all shrinkage cracks for their full depth within pavement, exterior slab and building areas. If grading is performed during the dry season, the shrinkage cracks may extend to a few feet below the surface. Therefore, it may be necessary to excavate a portion of the cracked soils to obtain the proper moisture condition and degree of compaction. Approved fill material should then be spread in thin lifts, uniformly moisture-conditioned to near optimum and properly compacted. All structural fills, including those placed to establish site surface drainage, should be compacted to at least 90 percent relative compaction. Expansive soils used as fill should be moisture-conditioned to at least 4 percent above optimum. Only approved select materials should be used for fill within the upper 30 inches of interior slab subgrades, where spread footings are used for foundation support, and within the upper 12 inches of exterior slab and pavement subgrade.

SUMMARY OF COMPACTION RECOMMENDATIONS	
Area	Compaction Recommendation (ASTM D-1557)
Preparation for areas to receive fill	After preparation in accordance with this report, compact upper 6 inches to a minimum of 90 percent relative compaction.
General fill (native or import)	Compact to a minimum of 90 percent relative compaction.
Structural fill beneath buildings, extending outward to 5' beyond building perimeter	Compact to a minimum of 90 percent relative compaction.
Trenches	Compact to a minimum of 90 percent relative compaction. Compact the top 6 inches below vehicle pavement subgrade to a minimum of 95 percent relative compaction.
Retaining wall backfill	Compact to a minimum of 90 percent relative compaction, but not more than 95 percent.
Pavements, extending outward to 3' beyond edge of pavement	Compact upper 6 inches of subgrade to a minimum of 95 percent relative compaction.
Concrete flatwork and exterior slabs, extending outward to 3' beyond edge of slab	Compact subgrade to a minimum of 90 percent relative compaction. Where subject to vehicle traffic, compact upper 6 inches of subgrade to at least 95 percent relative compaction.
Aggregate Base	Compact aggregate base to at least 95 percent relative compaction.

Permanent Cut and Fill Slopes

In general, cut and fill slopes should be designed and constructed at slope gradients of 2:1 (horizontal to vertical) or flatter, unless otherwise approved by the geotechnical engineer in specified areas. Where steeper slopes are required, retaining walls should be used.

Wet Weather Grading

Generally, grading is performed more economically during the summer months when on-site soils are usually dry of optimum moisture content. Delays should be anticipated in site grading performed during the rainy season or early spring due to excessive moisture in on-site soils. Special and relatively expensive construction procedures, including dewatering of excavations and importing granular soils, should be anticipated if grading must be completed during the winter and early spring or if localized areas of soft saturated soils are found during grading in the summer and fall.

Open excavations also tend to be more unstable during wet weather as groundwater seeps towards the exposed cut slope. Severe sloughing and occasional slope failures should be anticipated. The occurrence of these events will require extensive clean up and the installation of slope protection measures, thus delaying projects. The general contractor is responsible for the performance, maintenance and repair of temporary cut slopes.

Foundation Support

Provided the weak surface soils are removed by or strengthened by remedial grading as recommended herein, and the upper 30 inches of the building pad consists of select fill, the proposed structures can be supported on continuous and isolated spread footings that bottom on select engineered fill. Where 30 inches of select fill is not used, the structures can be supported on post-tensioned slabs-on-grade. Post-tensioned slabs-on-grade are required for the structures within the shallow liquefiable soil zone shown on Plate 2. Site walls and site retaining walls can be supported on spread footings that gain support in the firm, native soils.

Spread Footings

Spread footings for structures should be at least 12 inches wide and should bottom on select engineered fill at least 12 inches below pad subgrade. Spread footings for site walls and site retaining walls should be at least 18 and 24 inches wide, respectively, and bottom on firm, native soils at least 12 inches below lowest adjacent grade. Additional embedment or width may be needed to satisfy code and/or structural requirements. On ungraded sloping terrain, the footings should be stepped as necessary to produce level tops and bottoms. Footings should be deepened as necessary to provide at least 7 feet of horizontal confinement between the footing bottoms and the face of the nearest slope.

The bottoms of all footing excavations should be thoroughly cleaned out or wetted and compacted using hand-operated tamping equipment prior to placing steel and concrete. This will remove the soils disturbed during footing excavations, or restore their adequate bearing capacity, and reduce post-construction settlements. Footing excavations should not be allowed to dry before placing concrete. If shrinkage cracks appear in soils exposed in the footing excavations, the soil should be thoroughly moistened to close all cracks prior to concrete placement. The moisture condition of the foundation excavations should be checked by the geotechnical engineer no more than 24 hours prior to placing concrete.

Bearing Pressures - Footings installed in accordance with these recommendations may be designed using allowable bearing pressures of 2000, 3000 and 4000 pounds per square foot (psf), for dead loads, dead plus code live loads, and total loads (including wind and seismic), respectively.

Lateral Pressures - The portion of spread footing foundations extending into firm, native soil or select engineered fill may impose a passive equivalent fluid pressure and a friction factor of 350 pcf and 0.35, respectively, to resist sliding. Passive pressure on ungraded weak surface soil should be reduced to 150 pcf. Passive pressure should be neglected within the upper 6 inches, unless the soils are confined by concrete slabs or pavements.

Post-Tension Slabs

A post tension (PT) slab should be a designed to accommodate edge moisture variation distances of 4.9 and 7.5 feet for edge and center lift conditions, respectively, a differential edge swell of 0.95 inch and a center swell of 1.18 inch. These parameters were developed using the Post-Tensioning Institute manual "Design and Construction of Post-Tensioned Slabs-On-Ground, Third Edition" (2004). When using these criteria, PT slabs should be designed in accordance with the procedures of the Third Edition only. A PT slab installed in accordance with the foregoing recommendations may be designed using allowable bearing pressures of 2000, 3000 and 4000 pounds per square foot (psf) for dead loads, dead plus code live loads, and total loads, including wind and seismic, respectively. We recommend a minimum slab thickness of 10 inches and a 12-inch-wide (minimum) perimeter thickened edge. Concentrated loads in the slab interior should also be supported by thickened beams within the slab. The post-tensioned slabs within the zone of larger differential settlement, as shown on Plate 2, should be designed for liquefaction-induced differential settlement of 1¼ inches.

The PT slab should be underlain with a capillary moisture break consisting of at least 4 inches of clean, free-draining crushed rock or gravel (excluding pea gravel) at least ¼-inch and no larger than ¾-inch in size. The subgrade soils within and for a distance of 5 feet beyond the footprint of the building(s) should be kept pre-swelled until the capillary moisture break is placed. The moisture content of the subgrade soils should be approved by the geotechnical engineer within 24 hours prior to placing the capillary moisture break. Where migration of moisture vapor through slabs would be detrimental, a moisture vapor barrier should be provided.

Because PT slabs are designed to move with the expansive soils as they shrink and swell, structural elements that are attached to the structure, but have their own foundation should not be used or should be founded on the PT slab. Exterior flatwork and concrete walkway subgrades should be underlain by at least 12 inches of select fill and be pre-swelled by soaking prior to installation of the walkway. In addition, concrete walkways should be:

1. Cast separate from the PT slab to allow differential settlement to occur without distressing the walkway;

2. Reinforced to reduce cracks; and

3. Grooved to induce cracking in a non-obtrusive manner.

The Post-Tensioning Institute states “Consideration should be given to ‘artificial’ effects, such as planter units adjacent to structural bearing areas. Tree roots can be a serious problem and cause volume reduction in limited areas, thus causing distress to the slab foundation. Trees that are planted closer to the foundation than half their ultimate height can be expected to cause significant differential movement.”

Retaining Walls

Retaining walls constructed at the site must be designed to resist lateral earth pressures plus additional lateral pressures that may be caused by surcharge loads applied at the ground surface behind the walls. Retaining walls free to rotate (yielding greater than 0.1 percent of the wall height at the top of the backfill) should be designed for active lateral earth pressures. If walls are restrained by rigid elements to prevent rotation, they should be designed for “at rest” lateral earth pressures. Retaining walls should be designed to resist the following earth equivalent fluid pressures (triangular distribution):

EARTH EQUIVALENT FLUID PRESSURES		
Loading Condition	**Pressure (pcf)**	**Additional Seismic Pressure (pcf)***
Active - Level Backfill	42	13
Active - Sloping Backfill 3:1 or Flatter	53	30
At Rest - Level Backfill	63	31

* If required

These pressures do not consider additional loads resulting from adjacent foundations or other loads. If these additional surcharge loadings are anticipated, we can assist in evaluating their effects. Where retaining wall backfill is subject to vehicular traffic, the walls should be designed to resist an additional surcharge pressure equivalent to two feet of additional backfill.

Retaining walls will yield slightly during backfilling. Therefore, walls should be backfilled prior to building on, or adjacent to, the walls. Backfill against retaining walls should be compacted to at least 90 and not more than 95 percent relative compaction. Over-compaction or the use of large compaction equipment should be avoided because increased compactive effort can result in lateral pressures higher than those recommended above.

Foundation Support

Retaining walls should be supported on spread footings designed in accordance with the recommendations presented in this report. Retaining wall foundations should be designed by the project civil or structural engineer to resist the lateral forces set forth in this section.

Wall Drainage and Backfill

Retaining walls should be backdrained as shown on Plate 21, Appendix A. The backdrains should consist of 4-inch diameter, rigid perforated pipe embedded in Class 2 permeable material. The pipe should be PVC Schedule 40 or ABS with SDR 35 or better, and the pipe should be sloped to drain to outlets by gravity. The top of the pipe should be at least 8 inches below lowest adjacent grade. The Class 2 permeable material should extend to within 1½ feet of the surface. The upper 1½ feet should be backfilled with compacted soil to exclude surface water. Expansive soils should not be used for wall backfill. Where expansive soils are present in the excavation made to install the retaining wall, the excavation should be sloped back 1:1 from the back of the footing or grade beam. The ground surface behind retaining walls should be sloped to drain. Where migration of moisture through retaining walls would be detrimental, retaining walls should be waterproofed.

Slab-On-Grade

Provided grading is performed in accordance with the recommendations presented herein, interior and exterior slabs should be underlain by select engineered fill. Slab-on-grade subgrade should be rolled to produce a dense, uniform surface. The future expansion potential of the subgrade soils should be reduced by thoroughly presoaking the slab subgrade prior to concrete placement. The moisture condition of the subgrade soils should be checked by the geotechnical engineer no more than 24 hours prior to placing the capillary moisture break. The slabs should be underlain with a capillary moisture break consisting of at least 4 inches of clean, free-draining crushed rock or gravel (excluding pea gravel) at least ¼-inch and no larger than ¾-inch in size. Class 2 aggregate base can be used for slab rock under exterior slabs. Interior area slabs should be provided with an underdrain system. The installation of this subdrain system is discussed in the “Geotechnical Drainage” section.

Slabs should be designed by the project civil or structural engineer to support the anticipated loads, reduce cracking and provide protection against the infiltration of moisture vapor. A vapor barrier should be placed under all slabs-on-grade that are likely to receive an impermeable floor finish or be used for any purpose where the passage of water vapor through the floor is undesirable. RGH does not practice in the field of moisture vapor transmission evaluation or mitigation. Therefore, we recommend that a qualified person be consulted to evaluate the general and specific moisture vapor transmission paths and any impact on the proposed construction. This person should provide recommendations for mitigation of the potential adverse impact of moisture vapor transmission on various components of the structure as deemed appropriate.

Utility Trenches

The shoring and safety of trench excavations is solely the responsibility of the contractor. Attention is drawn to the State of California Safety Orders dealing with “Excavations and Trenches.”

Unless otherwise specified by the County of Sonoma, on-site, inorganic soil may be used as general utility trench backfill. Where utility trenches support pavements, slabs and foundations, trench backfill should consist of aggregate baserock. The baserock should comply with the minimum requirements in Caltrans Standard Specifications, Section 26 for Class 2 Aggregate Base. Trench backfill should be moisture-conditioned as necessary, and placed in horizontal layers not exceeding 8 inches in thickness, before compaction. Each layer should be compacted to at least 90 percent relative compaction as determined by ASTM Test Method D-1557. The top 6 inches of trench backfill below vehicle pavement subgrades should be moisture-conditioned as necessary and compacted to at least 95 percent relative compaction. Jetting or ponding of trench backfill to aid in achieving the recommended degree of compaction should not be attempted.

Pavements

Because of the very high expansion potential of the soil and bedrock at the site and the difficulty in controlling seasonal moisture variation beneath and adjacent to the driveway, significant cracking may develop in the pavement even if 12-inches of select fill is installed, as recommended herein. Increasing the thickness of select fill or installing moisture cutoffs may reduce but not eliminate the potential for cracks to develop. It should be understood that pavements will likely require regular maintenance including crack sealing and the aesthetics may not be desirable.

Provided the site grading is performed to remediate expansive soil heave, as recommended herein, the uppermost 12-inches of pavement subgrade soils will be either imported select fill with a minimum R-value of 20 or lime stabilized site soils that generally have an R-value of at least 50. Based on those R-values we recommend the pavement sections listed in the tables below be used.

PAVEMENT SECTIONS WITH IMPORTED SELECT FILL SUBGRADE

TI	ASPHALT CONCRETE (feet)	CLASS 2 AGGREGATE BASE (feet)	IMPORTED SELECT FILL* (feet)
7.0	0.30	1.15	1.0
6.0	0.25	1.05	1.0
5.0	0.20	0.90	1.0

* R-value ≥ 20

PAVEMENT SECTIONS WITH LIME STABILIZED SELECT FILL SUBGRADE

TI	ASPHALT CONCRETE (feet)	CLASS 2 AGGREGATE BASE (feet)	LIME STABILIZED SELECT FILL* (feet)
7.0	0.35	0.50	1.0
6.0	0.30	0.50	1.0
5.0	0.20	0.50	1.0

* R-value ≥ 50

Pavement thicknesses were computed using Caltrans CalFP v1.1 design software and are based on a pavement life of 20 years. These recommendations are intended to provide support for traffic represented by the indicated Traffic Indices. They are not intended to provide pavement sections for heavy concentrated construction storage or wheel loads such as forklifts, parked truck-trailers and concrete trucks (or for post-construction concentrated wheel loads such as self-loading dumpster trucks).

In areas where heavy construction storage and wheel loads are anticipated, the pavements should be designed to support these loads. Support could be provided by increasing pavement sections or by providing reinforced concrete slabs. Alternatively, paving can be deferred until heavy construction storage and wheel loads are no longer present. Loading areas for self-loading dumpster trucks should be provided with reinforced concrete slabs at least 6 inches thick, and reinforced with No. 4 bars at 12-inch centers each way. Alternatively, the asphalt concrete section should be increased to at least 8 inches in these areas.

Because of the expansion potential of the soil at the site and the difficulty in controlling seasonal moisture variation beneath and adjacent to the driveway, significant cracking may develop in the pavement even if 12-inches of select fill is installed. Increasing the thickness of select fill or installing moisture cutoffs may reduce but not eliminate the potential for cracks to develop. It should be understood that pavements will likely require regular maintenance including crack sealing and the aesthetics may not be desirable.

Prior to placement of aggregate base, the upper 6 inches of the pavement subgrade soils (excluding lime stabilized soils) should be scarified, uniformly moisture-conditioned to near optimum, and compacted to at least 95 percent relative compaction to form a firm, non-yielding surface. Lime stabilized select fill subgrade soils should be compacted as specified in Section 24 of the Caltrans Standard Specifications. Aggregate base materials should be spread in thin layers, uniformly moisture-conditioned, and compacted to at least 95 percent relative compaction to form a firm, non-yielding surface. The materials and methods used should conform to the requirements of the City of Santa Rosa and the current edition of the Caltrans Standard Specifications, except that compaction requirements should be based on ASTM Test Method D-1557. Aggregate used for the base course should comply with the minimum requirements specified in Caltrans Standard Specifications, Section 26 for Class 2 Aggregate Base.

Porous/Permeable Surface Treatments

Because porous surface treatments are designed to allow water to drain through to the underlying subgrade, standard design procedures are not applicable because standard concrete, dense-graded asphalt and Class 2 aggregate base rock do not allow drainage. There is no established design procedure or known lifetime performance for porous travel surfaces. In addition, porous concrete and pavement are not typically as durable as standard concrete and dense-graded asphalt. Therefore, if porous surface treatments are used, it should be understood that regular maintenance and repair may be required and will be on-going through the life of the paved area. In addition, porous surface treatments are suitable for light automobile traffic only and should be avoided in areas where heavy wheel loads, such as self-loading dumpster trucks, are anticipated.

Porous Pavement - According to the National Asphalt Pavement Association (NAPA) Guide for Porous Asphalt Pavements (Hansen, 2008), the porous asphalt layer is typically 2½ to 6 inches thick and depends on the anticipated traffic loading. According to the NAPA guide, 1.7 inches of open-graded porous asphalt is equivalent to 1.0 inch of dense-graded (non-porous) asphalt. The porous pavement surfaces will not be underlain by select engineered fill or lime treated on-site soils, therefore we used an R-value of 5 for the design of the porous pavement sections, which are in the table below.

POROUS PAVEMENT THICKNESS	
TI	ASPHALT CONCRETE (feet)
7.0	0.60
6.0	0.43
5.0	0.34

The asphalt should be underlain with 2 inches of ½-inch clean, crushed rock over a recharge bed consisting of at least 18 inches of uniformly graded clean, crushed rock meeting the specification for ASTM Size No. 2 or No. 3 with the additional requirement of 0 to 2 percent passing the No. 100 sieve. In addition, the rock should have 40 percent minimum voids as determined by ASTM C29. The thickness of the recharge bed can be increased if required to contain greater stormwater runoff. Aggregate should be placed in 8 to 12 inch lifts and each lift should be compacted with a single pass of a light roller or vibratory plate compactor. The rock section should be underlain with non-woven filter fabric such as Mirafi 180N or approved equivalent. To help maximize water infiltration into the ground, the subgrade below the filter fabric should not be compacted and equipment traffic should be avoided prior to installing the rock section. The exposed subgrade soil should be reviewed during construction to assess their ability to support the design section. In the absence of compaction, it is possible that a geogrid, such as Mirafi BXG120, may be required to assist in stabilizing the subgrade. If fills are required to make subgrade, the fills should consist of crushed rock as soil fills will reduce the infiltration.

It is critical to protect the porous pavement during and after construction from sediment laden water and construction debris that may clog it. During construction, this will require careful sequencing of work including traffic patterns or constructing certain areas with dense-graded asphalt where construction traffic will be concentrated. It is also essential that porous pavements not be seal coated by maintenance personnel during the pavement lifetime.

Porous Concrete Walkways - Porous concrete walkways should be underlain with at least 4 inches of ½-inch crushed rock over filter fabric and non-compacted native soil as discussed above for pavements. Walkways constructed in this manner will be suitable for pedestrian traffic only.

Drainage - The infiltration testing and soil percolation suitability testing performed should be evaluated by the project civil engineer in order to evaluate the drainage needed for porous surface treatments. Porous surface treatments may require perforated drain lines installed to allow drainage of water that is not able to infiltrate into the ground.

Parking Lot Drainage

Water tends to migrate under pavements and collect in the aggregate courses at low areas on parking lot subgrade soils, such as around storm drain inlets and the thread of paved swales leading to inlets. The ponded water will soften subgrade soils and, under repetitive heavy-wheel loads, will induce inordinately high stresses on the subgrade and pavement components that could result in untimely maintenance. Under-pavement drainage can be improved and maintenance reduced by replacing a 12-inch wide strip (extending at least 15 feet on either side of the inlet) of the select subbase layer or subgrade soils with a subdrain consisting of ¾-inch or 1½-inch free-draining Class 1 Permeable Material. The drain rock should be outletted into the storm drain inlet. Storm drain trenches can be made to serve as pavement subdrains. We should be consulted to verify the suitability of storm drain trenches as pavement subdrains in a case-specific basis.

Where pavements will abut landscaped areas, the pavement baserock layer and subgrade soils should be protected against saturation from irrigation and rainwater with a subdrain, similar to that previously discussed. The subdrain should extend to a depth of at least 6 inches below the bottom of the baserock layer. Alternatively, a grouted moisture cut-off that extends 12 inches below the bottom of the baserock layer should be provided below or immediately behind the curb and gutter.

Wet Weather Paving

In general, the pavements should be constructed during the dry season to avoid the saturation of the subgrade and base materials, which often occurs during the wet winter months. If pavements are constructed during the winter, a cost increase relative to drier weather construction should be anticipated. Unstable areas may have to be overexcavated to remove soft soils. The excavations will probably require backfilling with imported crushed (ballast) rock. The geotechnical engineer should be consulted for recommendations at the time of construction.

Geotechnical Drainage

Surface

Surface water should be diverted away from slopes, foundations and edges of pavements. Surface drainage gradients should slope away from building foundations in accordance with the requirements of the CBC or local governing agency. Where a gradient flatter than 2 percent for paved areas and 4 percent for unpaved areas is required to satisfy design constraints, area drains should be installed with spacing no greater than about 20 feet. Roofs should be provided with gutters and the downspouts should be connected to closed (glued Schedule 40 PVC or ABS with SDR of 35 or better) conduits discharging well away from foundations onto paved areas or erosion resistant natural drainages or into the site's surface drainage system. Roof downspouts and surface drains must be maintained entirely separate from the slab underdrains recommended hereinafter.

Water seepage or the spread of extensive root systems into the soil subgrade of footings, slabs or pavements could cause differential movements and consequent distress in these structural elements. Landscaping should be planned with consideration for these potential problems.

Slab Underdrains

Where interior slab subgrades are less than 6 inches above adjacent exterior grade and where migration of moisture through the slab would be detrimental, slab underdrains should be installed to dispose of surface and/or groundwater that may seep and collect in the slab rock. Slab underdrains should consist of 6-inch wide trenches that extend at least 6 inches below the bottom of the slab rock and slope to drain by gravity. The slab underdrain trenches should be spaced no further than 20 feet, both ways. Additional drain trenches should be installed, as necessary, to drain all isolated under slab areas. Four-inch diameter perforated pipe (SDR 35 or better) sloped to drain to outlets by gravity should be placed in the bottom of the trenches. Slab underdrain trenches should be backfilled to subgrade level with clean, free draining slab rock. An illustration of this system is shown on Plate 22. If slab underdrains are not used, it should be anticipated that water will enter the slab rock, permeate through the concrete slab and ruin floor coverings.

Maintenance

Periodic land maintenance will be required. Surface and subsurface drainage facilities should be checked frequently, and cleaned and maintained as necessary or at least annually. A dense growth of deep-rooted ground cover must be maintained on all slopes to reduce sloughing and erosion. Sloughing and erosion that occurs must be repaired promptly before it can enlarge.

Supplemental Services

Pre-Bid Meeting

It has been our experience that contractors bidding on the project often contact us to discuss the geotechnical aspects. Informal contacts between RGH and an individual contractor could result in incomplete or misinterpreted information being provided to the contractor. Therefore, we recommend a pre-bid meeting be held to answer any questions about the report prior to submittal of bids. If this is not possible, questions or clarifications regarding this report should be directed to the project owner or their designated representative. After consultation with RGH, the project owner or their representative should provide clarifications or additional information to all contractors bidding the job.

Plan and Specifications Review

Coordination between the design team and the geotechnical engineer is recommended to assure that the design is compatible with the soil, geologic and groundwater conditions encountered during our study. RGH recommends that we be retained to review the project plans and specifications to determine if they are consistent with our recommendations. In the event we are not retained to perform this recommended review, we will assume no responsibility for misinterpretation of our recommendations.

Construction Observation and Testing

Prior to construction, a meeting should be held at the site that includes, but is not limited to, the owner or owner's representative, the general contractor, the grading contractor, the foundation contractor, the underground contractor, any specialty contractors, the project civil engineer, other members of the project design team and RGH. This meeting should serve as a time to discuss and answer questions regarding the recommendations presented herein and to establish the coordination procedure between the contractors and RGH.

In addition, we should be retained to monitor all soils related work during construction, including:

- Site stripping, over-excavation, grading, and compaction of near surface soils;
- Placement of all engineered fill and trench backfill with verification field and laboratory testing;
- Observation of all foundation excavations; and
- Observation of foundation and subdrain installations.

If, during construction, we observe subsurface conditions different from those encountered during the explorations, we should be allowed to amend our recommendations accordingly. If different conditions are observed by others, or appear to be present beneath excavations, RGH should be advised at once so that these conditions may be evaluated and our recommendations reviewed and updated, if warranted. The validity of recommendations made in this report is contingent upon our being notified and retained to review the changed conditions.

If more than 18 months have elapsed between the submission of this report and the start of work at the site, or if conditions have changed because of natural causes or construction operations at, or adjacent to, the site, the recommendations made in this report may no longer be valid or appropriate. In such case, we recommend that we be retained to review this report and verify the applicability of the conclusions and recommendations or modify the same considering the time lapsed or changed conditions. The validity of recommendations made in this report is contingent upon such review.

These supplemental services are performed on an as-requested basis and are in addition to this geotechnical study. We cannot accept responsibility for items that we are not notified to observe or for changed conditions we are not allowed to review.

LIMITATIONS

This report has been prepared by RGH for the exclusive use of Episcopal Senior Communities and their consultants as an aid in the design and construction of the proposed structures described in this report.

The validity of the recommendations contained in this report depends upon an adequate testing and monitoring program during the construction phase. Unless the construction monitoring and testing program is provided by our firm, we will not be held responsible for compliance with design recommendations presented in this report and other addendum submitted as part of this report.

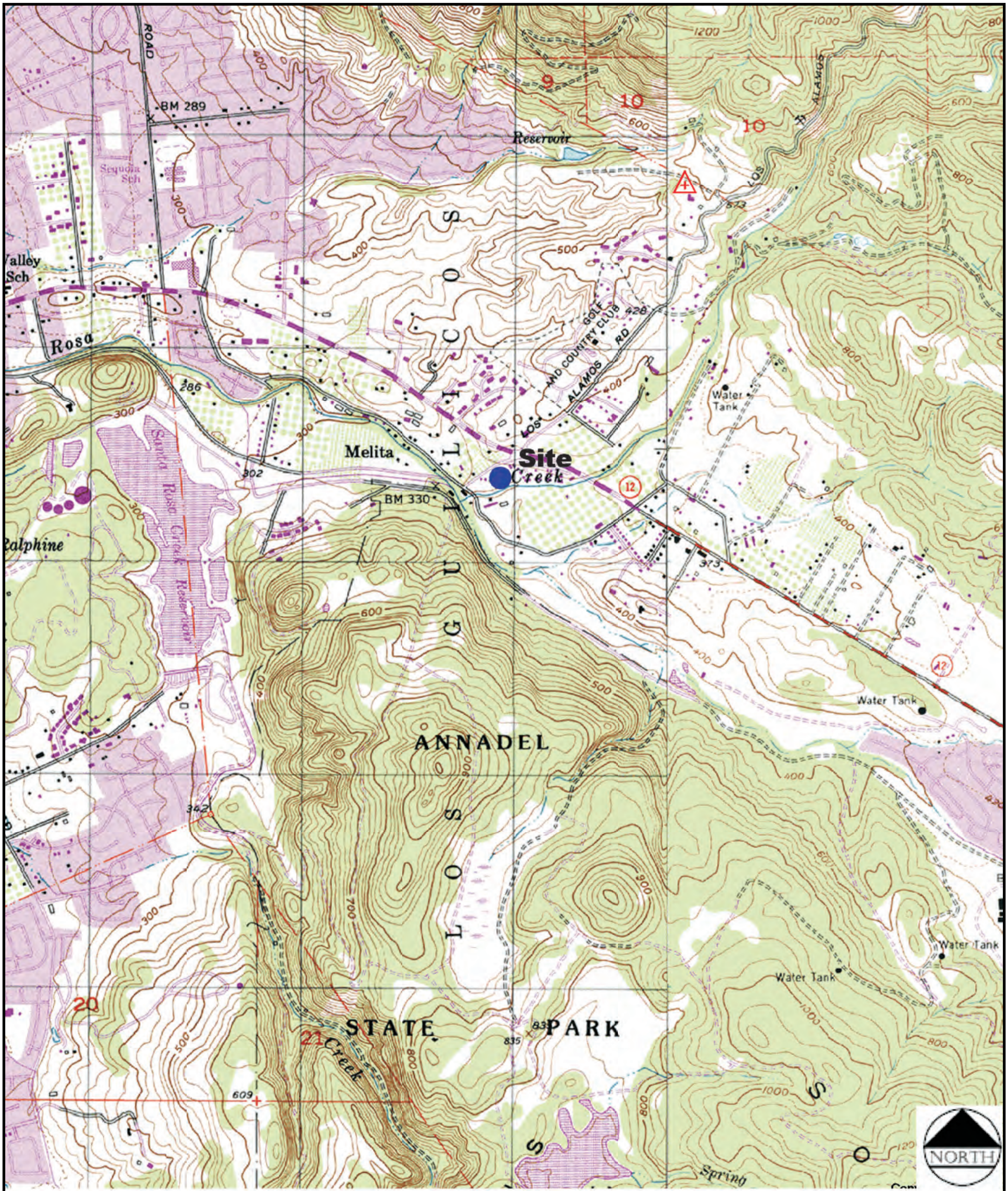
Our services consist of professional opinions and conclusions developed in accordance with generally accepted geotechnical engineering principles and practices. We provide no warranty, either expressed or implied. Our conclusions and recommendations are based on the information provided to us regarding the proposed construction, the results of our field exploration, laboratory testing program, and professional judgment. Verification of our conclusions and recommendations is subject to our review of the project plans and specifications, and our observation of construction.

The borings represent subsurface conditions at the locations and on the date indicated. It is not warranted that they are representative of such conditions elsewhere or at other times. Site conditions and cultural features described in the text of this report are those existing at the time of our field exploration on December 12 and 13, 2014, and on January 26, 2017, and may not necessarily be the same or comparable at other times.

The scope of our services did not include an environmental assessment or a study of the presence or absence of toxic mold and/or hazardous, toxic or corrosive materials in the soil, surface water, groundwater or air (on, below or around this site), nor did it include an evaluation or study for the presence or absence of wetlands. These studies should be conducted under separate cover, scope and fee and should be provided by a qualified expert in those fields.

APPENDIX A - PLATES

LIST OF PLATES



Reference: Maptech Topoquad, Santa Rosa & Kenwood, California Quadrangles

Scale: 1" = 2000'

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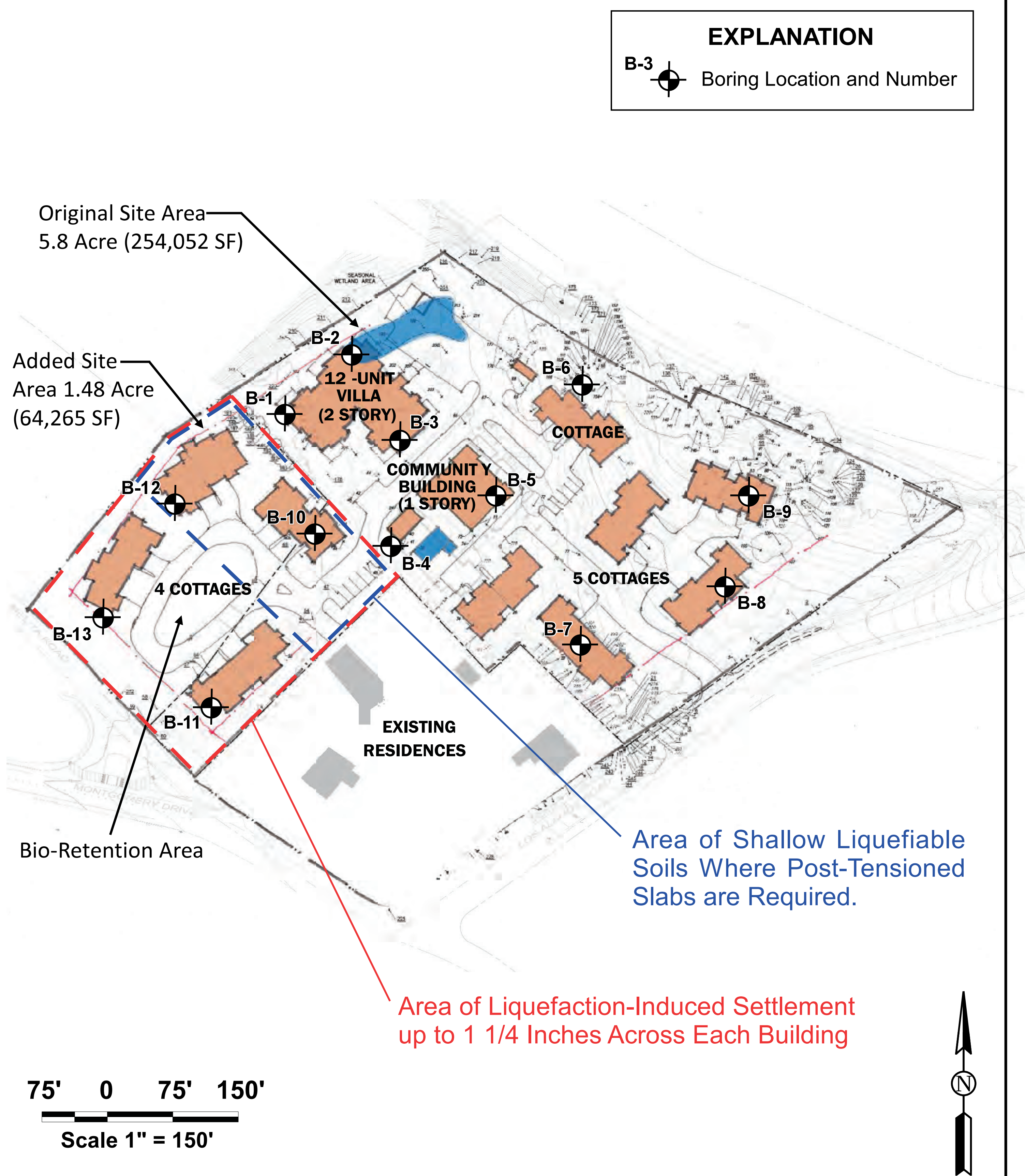
Job No: 2411.05.05.1 | Date: FEB 2017

SITE LOCATION MAP
Spring Lake Village East Grove
Highway 12 & Los Alamos Road
Santa Rosa, California

PLATE 1



Reference: Spring Lake Village - East Grove Development, Modified Original Site Plan Scheme, page 4.

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Job No: 2411.05.05.1 | Date: FEB 2017

EXPLORATION PLAN
Spring Lake Village East Grove
Highway 12 & Los Alamos Road
Santa Rosa, California

PLATE
2

Date(s) Drilled **12/13/14**	Logged By **BPC**	Checked By **EGC**
Drilling Method **Hollow Stem Auger**	Drill Bit Size/Type **8-inch HSA**	Total Depth of Borehole **21-1/2 feet**
Drill Rig Type **CME-55 Track-Mounted**	Drilling Contractor **Taber**	Approximate Surface Elevation **Existing Ground Surface**
Groundwater Level and Date Measured **1/2 foot bgs**	Sampling Method(s) **Modified California**	Hammer Data **140 lb, 30 inch drop**

Elevation (feet)	Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Graphic Log	MATERIAL DESCRIPTION	Dry Density (pcf)	Water Content (%)	% <#200 Sieve	PI, %	LL, %	Expansion Index (EI)	UC, ksf	REMARKS AND OTHER TESTS
	0				BROWN SANDY CLAY (CL). Medium stiff, moist, slightly porous. ▽								
		■	6		ORANGE-GREY CLAYEY GRAVEL WITH SAND (GC). Loose, wet, fine to coarse sand, fine angular gravel.								
		■	34		MOTTLED ORANGE-GREY CLAYEY GRAVEL WITH SAND (GC). Dense, wet.								
	5	■	35										
	10	■	55+/7"		GREY GRAVEL WITH CLAY AND SAND (GP-GC). Very dense, wet, fine to coarse sand, fine angular gravel.								
					GREY CLAYEY SAND (SC). Dense, moist, fine sand.								
	15	■	50/6"										
					GREY-BROWN SAND WITH GRAVEL (SP). Very dense, moist to wet, fine to coarse sand, subrounded gravel to 1/2-inch diameter, trace fines.								
	20	■	55+/5"										
					Boring terminated at 21-1/2 feet bgs. Free water encountered at 1/2 foot bgs.								

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Job No: 2411.05.05.1 | Date: FEB 2017

LOG OF BORING B-1
Spring Lake Village East Grove
Highway 12 & Los Alamos Road
Santa Rosa, California

PLATE
3

Date(s) Drilled **12/12/14**	Logged By **BPC**	Checked By **EGC**
Drilling Method **Solid & Hollow Stem Auger**	Drill Bit Size/Type **4-inch SSA & 8-inch HSA**	Total Depth of Borehole **21-1/2 feet**
Drill Rig Type **CME-55 Track-Mounted**	Drilling Contractor **Taber**	Approximate Surface Elevation **Existing Ground Surface**
Groundwater Level and Date Measured **1 foot bgs**	Sampling Method(s) **Modified California, SPT**	Hammer Data **140 lb, 30 inch drop**

Elevation (feet)	Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Graphic Log	MATERIAL DESCRIPTION	Dry Density (pcf)	Water Content (%)	% <#200 Sieve	PI, %	LL, %	Expansion Index (EI)	UC, ksf	REMARKS AND OTHER TESTS
	0				BROWN SANDY CLAY (CL). Medium stiff, moist to wet, slightly porous. ▽								
			24		MOTTLED GREY-ORANGE CLAYEY SAND (SC). Medium-dense, moist, occasional subangular gravel to 3/4-inch diameter.	104	19.4	49.8	18	36	85		
	5		23		GREY-BROWN CLAYEY SAND WITH GRAVEL (SC). Medium dense, wet, fine subangular gravel, occasional gravel to 2-inch diameter.	111	17.2	19.5					
			31		GREY-BROWN SAND WITH GRAVEL (SP). Dense, wet, medium to coarse sand, occasional subrounded gravel to 2-inch diameter.	123	12.4						
	10		41										
	15		50/6"		RED-GREY GRAVEL WITH CLAY AND SAND (GP-GC). Very dense, wet, fine to coarse sand, subangular gravel to 2-inch diameter.								
	20		55+/7"										
					Boring Terminated at 21-1/2 feet bgs. Free Water Encountered at 1 foot bgs.								

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LOG OF BORING B-2

Spring Lake Village East Grove
Highway 12 & Los Alamos Road
Santa Rosa, California

PLATE

4

Date(s) Drilled **12/13/14**	Logged By **BPC**	Checked By **EGC**
Drilling Method **Solid & Hollow Stem Auger**	Drill Bit Size/Type **4-inch SSA & 8-inch HSA**	Total Depth of Borehole **15-1/2 feet**
Drill Rig Type **CME-55 Track-Mounted**	Drilling Contractor **Taber**	Approximate Surface Elevation **Existing Ground Surface**
Groundwater Level and Date Measured **1 foot bgs**	Sampling Method(s) **Modified California**	Hammer Data **140 lb, 30 inch drop**

Elevation (feet)	Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Graphic Log	MATERIAL DESCRIPTION	Dry Density (pcf)	Water Content (%)	% <#200 Sieve	PI, %	LL, %	Expansion Index (EI)	UC, ksf	REMARKS AND OTHER TESTS
	0				BROWN SANDY CLAY (CL). Medium stiff, wet, slightly porous. ∇								
			18		MOTTLED RED-BROWN CLAYEY SAND WITH GRAVEL (SC). Medium-dense, moist, fine to coarse sand.								
			23					21.5					
	5		40		Dense, increasing gravel size, sub-rounded gravels to 2-inch diameter.								
	10		54/4"		GREY GRAVEL WITH CLAY AND SAND (GC). Dense, wet, subangular gravel up to 1-1/2-inch diameter.								
	15		55+/5"										
					Boring Terminated at 15-1/2 feet bgs. Free water encountered at 1 foot bgs.								
	20												

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LOG OF BORING B-3

Spring Lake Village East Grove
Highway 12 & Los Alamos Road
Santa Rosa, California

PLATE

5

Date(s) Drilled	12/13/14	Logged By	BPC	Checked By	EGC
Drilling Method	Hollow Stem Auger	Drill Bit Size/Type	8-inch HSA	Total Depth of Borehole	21-1/2 feet
Drill Rig Type	CME-55 Track-Mounted	Drilling Contractor	Taber	Approximate Surface Elevation	Existing Ground Surface
Groundwater Level and Date Measured	1/2 foot bgs	Sampling Method(s)	Modified California	Hammer Data	140 lb, 30 inch drop

Elevation (feet)	Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Graphic Log	MATERIAL DESCRIPTION	Dry Density (pcf)	Water Content (%)	% <#200 Sieve	PI, %	LL, %	Expansion Index (EI)	UC, ksf	REMARKS AND OTHER TESTS
	0				BROWN SANDY CLAY (CL). Medium stiff, wet, slightly porous.								
			15		MOTTLED ORANGE-BROWN CLAYEY SAND WITH GRAVEL (SC). Medium dense, moist, fine to coarse sand.								
	5		20		Occassional small gravel.			27.3					
			23		MOTTLED GREY-ORANGE CLAYEY SAND WITH GRAVEL (SC). Medium dense, moist, fine to coarse sand, trace fines.			27.4					
	10		55+/4"		GREY GRAVEL WITH SAND (GP). Very dense, wet, rounded and subangular gravel to 2-inch diameter, trace fines.								
	15				BLUE-GREY GRAVEL WITH SAND (GP). Medium dense, wet, coarse sand, fine gravel, occasional subangular gravel to 2-inch diameter.								
			35		GREY SAND WITH GRAVEL (SP). Medium dense, moist, fine sand.								
	20		55+		GREY CLAYEY SAND WITH GRAVEL (SC). Very dense, moist to wet, subangular gravel to 2-inch diameter.								
					Boring Terminated at 21-1/2 feet bgs. Free water encountered at 1/2 foot bgs.								

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Job No: 2411.05.05.1 | Date: FEB 2017

LOG OF BORING B-4
Spring Lake Village East Grove
Highway 12 & Los Alamos Road
Santa Rosa, California

PLATE 6

Date(s) Drilled **12/12/14**	Logged By **BPC**	Checked By **EGC**
Drilling Method **Solid Stem Auger**	Drill Bit Size/Type **4-inch SSA**	Total Depth of Borehole **16-1/2 feet**
Drill Rig Type **CME-55 Track-Mounted**	Drilling Contractor **Taber**	Approximate Surface Elevation **Existing Ground Surface**
Groundwater Level and Date Measured **1-1/2 feet bgs**	Sampling Method(s) **Modified California**	Hammer Data **140 lb, 30 inch drop**

Elevation (feet)	Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Graphic Log	MATERIAL DESCRIPTION	Dry Density (pcf)	Water Content (%)	% <#200 Sieve	PI, %	LL, %	Expansion Index (EI)	UC, ksf	REMARKS AND OTHER TESTS
	0				BROWN SANDY CLAY WITH GRAVEL (CH). Medium stiff, moist, occasional fine sand and gravel.								
			7					54	52	69			
			50/4"		MOTTLED GREY-BROWN SANDY CLAY (CL). Hard, moist, fine to coarse sand, occasional angular gravel to 1/2-inch diameter.								
	5		55+										
					MOTTLED GREY-ORANGE-BROWN GRAVELLY CLAY WITH SAND (CL). Stiff, moist, fine to coarse sand.								
	10		14										
					MOTTLED ORANGE-GREY-BROWN GRAVEL WITH CLAY AND SAND (GP-GC). Dense, moist, fine to coarse sand.								
	15		47/10"										
					Boring terminated at 16-1/2 feet bgs. Free water encountered at 1-1/2 feet bgs.								
	20												

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Job No: 2411.05.05.1 | Date: FEB 2017

LOG OF BORING B-5

Spring Lake Village East Grove
Highway 12 & Los Alamos Road
Santa Rosa, California

PLATE

7

Date(s) Drilled: **12/12/14**	Logged By: **BPC**	Checked By: **EGC**
Drilling Method: **Solid Stem Auger**	Drill Bit Size/Type: **4-inch SSA**	Total Depth of Borehole: **21-1/2 feet**
Drill Rig Type: **CME-55 Track-Mounted**	Drilling Contractor: **Taber**	Approximate Surface Elevation: **Existing Ground Surface**
Groundwater Level and Date Measured: **NFWE**	Sampling Method(s): **Modified California**	Hammer Data: **140 lb, 30 inch drop**

Elevation (feet)	Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Graphic Log	MATERIAL DESCRIPTION	Dry Density (pcf)	Water Content (%)	% <#200 Sieve	PI, %	LL, %	Expansion Index (EI)	UC, ksf	REMARKS AND OTHER TESTS
	0				MOTTLED RED-BROWN GRAVELLY CLAY w/SAND (CH). Very stiff, moist, fine to coarse sand, occasional root, slightly porous.								
			22										
			55+/9"		LIGHT GREY-BROWN SAND WITH CLAY AND GRAVEL (SP-SC). Dense, moist, fine to coarse sand.								
	5												
			30										
					MOTTLED ORANGE-GREY GRAVEL WITH CLAY AND SAND (GP-GC). Dense, moist, fine to coarse sand, subangular gravel to 2-inch diameter.								
	10		36										
	15		35		Increasing gravel size.								
	20		35										
					Boring terminated at 21-1/2 feet bgs. No free water encountered.								

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Job No: 2411.05.05.1 | Date: FEB 2017

LOG OF BORING B-6
Spring Lake Village East Grove
Highway 12 & Los Alamos Road
Santa Rosa, California

PLATE **8**

Date(s) Drilled **12/12/14**	Logged By **BPC**	Checked By **EGC**
Drilling Method **Solid Stem Auger**	Drill Bit Size/Type **4-inch SSA**	Total Depth of Borehole **16-1/2 feet**
Drill Rig Type **CME-55 Track-Mounted**	Drilling Contractor **Taber**	Approximate Surface Elevation **Existing Ground Surface**
Groundwater Level and Date Measured **NFWE**	Sampling Method(s) **Modified California**	Hammer Data **140 lb, 30 inch drop**

Elevation (feet)	Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Graphic Log	MATERIAL DESCRIPTION	Dry Density (pcf)	Water Content (%)	% <#200 Sieve	PI, %	LL, %	Expansion Index (EI)	UC, ksf	REMARKS AND OTHER TESTS
	0				GREY-BROWN CLAY WITH SAND (CL). Medium stiff, wet, occasional subangular gravel to 1-1/2-inch diameter, slightly porous.								
			15		LIGHT BROWN CLAYEY SAND WITH GRAVEL (SC). Medium dense, moist, fine to coarse sand.								
			32/6"		GREY-BROWN GRAVEL WITH CLAY AND SAND (GP-GC). Medium dense, moist, fine to coarse sand.								
	5												
			49		MOTTLED GREY-ORANGE-BROWN CLAYEY SAND (SC). Dense, moist, fine to medium sand.								
	10				MOTTLED GREY-ORANGE SANDY CLAY (CL). Medium dense, moist, fine sand.								
			21					57.6					
	15												
			19					68.5	27	47			
					Boring terminated at 16-1/2 feet bgs. No free water encountered.								
	20												

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Job No: 2411.05.05.1 | Date: FEB 2017

LOG OF BORING B-7

Spring Lake Village East Grove
Highway 12 & Los Alamos Road
Santa Rosa, California

PLATE 9

Date(s) Drilled	12/12/14	Logged By	BPC	Checked By	EGC
Drilling Method	Solid Stem Auger	Drill Bit Size/Type	4-inch SSA	Total Depth of Borehole	16-1/2 feet
Drill Rig Type	CME-55 Track-Mounted	Drilling Contractor	Taber	Approximate Surface Elevation	Existing Ground Surface
Groundwater Level and Date Measured	NFWE	Sampling Method(s)	Modified California	Hammer Data	140 lb, 30 inch drop

Elevation (feet)	Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Graphic Log	MATERIAL DESCRIPTION	Dry Density (pcf)	Water Content (%)	% <#200 Sieve	PI, %	LL, %	Expansion Index (EI)	UC, ksf	REMARKS AND OTHER TESTS
	0				BROWN CLAY WITH SAND (CH). Stiff, wet, fine sand.								
			15										
					MOTTLED GREY-ORANGE-BROWN CLAYEY SAND (SC). Very dense, moist, fine sand.								
	5		54										
			38		MOTTLED GREY-ORANGE-BROWN SAND WITH CLAY (SP-SC). Dense, moist, fine sand.								
					RED-BROWN CLAYEY SAND (SC). Medium dense, moist, fine to medium sand, increasing gravel content with depth.								
	10		16					21.4	21	38			
					MOTTLED GREY-ORANGE-BROWN GRAVEL WITH CLAY AND SAND (GP-GC). Very dense, moist, fine to medium sand.								
	15		55+										
					Boring terminated at 16-1/2 feet bgs. No free water encountered.								
	20												

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Job No: 2411.05.05.1 | Date: FEB 2017

LOG OF BORING B-8
Spring Lake Village East Grove
Highway 12 & Los Alamos Road
Santa Rosa, California

PLATE
10

Date(s) Drilled **12/12/14**	Logged By **BPC**	Checked By **EGC**
Drilling Method **Solid Stem Auger**	Drill Bit Size/Type **4-inch SSA**	Total Depth of Borehole **16-1/2 feet**
Drill Rig Type **CME-55 Track-Mounted**	Drilling Contractor **Taber**	Approximate Surface Elevation **Existing Ground Surface**
Groundwater Level and Date Measured **NFWE**	Sampling Method(s) **Modified California**	Hammer Data **140 lb, 30 inch drop**

Elevation (feet)	Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Graphic Log	MATERIAL DESCRIPTION	Dry Density (pcf)	Water Content (%)	% <#200 Sieve	PI, %	LL, %	Expansion Index (EI)	UC, ksf	REMARKS AND OTHER TESTS
	0				BROWN CLAY WITH SAND (CH). Stiff, moist, fine sand.								
			14			107.1	20.3					12,275	
						91.1	31.4	76.6	53	71	153		
					MOTTLED GREY-ORANGE CLAYEY SAND (SC). Dense to very dense, moist, fine sand.								
			55+			94	23.7						
	5		48			101	18.5						
	10		55+			102	15.7						
					MOTTLED RED-ORANGE-BROWN GRAVEL WITH CLAY AND SAND (GP-GC). Very dense, moist.								
	15		55+										
					Boring terminated at 16-1/2 feet bgs. No free water encountered.								
	20												

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Job No: 2411.05.05.1 | Date: FEB 2017

LOG OF BORING B-9
Spring Lake Village East Grove
Highway 12 & Los Alamos Road
Santa Rosa, California

PLATE
11

Date(s) Drilled **1/24/2017**	Logged By **DAV**	Checked By **EGC**
Drilling Method **Hollow Stem Auger**	Drill Bit Size/Type **8-inch HSA**	Total Depth of Borehole **15-1/2 feet**
Drill Rig Type **CME-55 Track-Mounted**	Drilling Contractor **Taber Drilling**	Approximate Surface Elevation **Existing Ground Surface**
Groundwater Level and Date Measured **2-1/2 feet**	Sampling Method(s) **Modified California**	Hammer Data **140 lb, 30-inch autotrip**

Elevation (feet)	Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Graphic Log	MATERIAL DESCRIPTION	Dry Density (pcf)	Water Content (%)	% <#200 Sieve	PI, %	LL, %	Expansion Index (EI)	UC, ksf	REMARKS AND OTHER TESTS
	0				BROWN CLAYEY SAND WITH GRAVEL (SC), Loose to medium dense, wet, fine to coarse sand, porous with rootlets to 2 feet.								
			10					35.5	30	53	48		
					▽ (groundwater)								
			49		Some cobbles								
	5				BROWN CLAYEY SAND WITH GRAVEL (SC), Medium dense, moist, fine to coarse sand and gravel, some cobbles.								
			14					15					
					GRAY AND BLUE SAND WITH CLAY AND GRAVEL (SC), Medium dense, moist, fine to coarse sand, fine to medium gravel.								
	10		27										
					BLUE SAND WITH CLAY (SC), Very dense, moist, fine sand.								
	15		55+										
					Boring terminated at 15-1/2 feet. Free water encountered at 2-1/2 feet.								
	20												

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LOG OF BORING B-10

Spring Lake Village East Grove
Highway 12 & Los Alamos Road
Santa Rosa, California

PLATE

12

Date(s) Drilled **1/24/2017**	Logged By **DAV**	Checked By **EGC**
Drilling Method **Hollow Stem Auger**	Drill Bit Size/Type **8-inch HSA**	Total Depth of Borehole **13-1/2 feet**
Drill Rig Type **CME-55 Track-Mounted**	Drilling Contractor **Taber Drilling**	Approximate Surface Elevation **Existing Ground Surface**
Groundwater Level and Date Measured **1-1/2 feet**	Sampling Method(s) **Bulk, Modified California**	Hammer Data **140 lb, 30-inch autotrip**

Elevation (feet)	Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Graphic Log	MATERIAL DESCRIPTION	Dry Density (pcf)	Water Content (%)	% <#200 Sieve	PI, %	LL, %	Expansion Index (EI)	UC, ksf	REMARKS AND OTHER TESTS
	0	Bulk		CL	BROWN CLAY WITH SAND (CL), Medium stiff, wet, rootlets, porous. (Groundwater at 1-1/2 feet)								
		Modified California	25	GC	LIGHT BROWN CLAYEY GRAVEL WITH SAND (GC), Medium dense, wet, fine to coarse sand and gravel.								
		Bulk											
	5	Modified California	39+										
		Modified California	54+	SP	BLUE-GRAY SAND WITH GRAVEL (SP), Very dense, moist, fine sand.								
	10			GP	BLUE-GRAY GRAVEL WITH SAND (GP), Very dense, dry to moist, fine to coarse sand and angular gravel.								
		Modified California	100+										
					Drilling refusal at 13-1/2 feet. Free water encountered at 1-1/2 feet.								
	15												
	20												

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LOG OF BORING B-11
Spring Lake Village East Grove
Highway 12 & Los Alamos Road
Santa Rosa, California

PLATE

13

Date(s) Drilled **1/24/2017**		Logged By **DAV**		Checked By **EGC**	
Drilling Method **Hollow Stem Auger**		Drill Bit Size/Type **8-inch HSA**		Total Depth of Borehole **13-1/2 feet**	
Drill Rig Type **CME-55 Track-Mounted**		Drilling Contractor **Taber Drilling**		Approximate Surface Elevation **Existing Ground Surface**	
Groundwater Level and Date Measured **1-1/2 feet**		Sampling Method(s) **Modified California, SPT**		Hammer Data **140 lb, 30-inch autotrip**	

Elevation (feet)	Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Graphic Log	MATERIAL DESCRIPTION	Dry Density (pcf)	Water Content (%)	% <#200 Sieve	PI, %	LL, %	Expansion Index (EI)	UC, ksf	REMARKS AND OTHER TESTS
	0				DARK BROWN CLAY WITH SAND (CL), Very stiff, wet, fine sand, porous with rootlets.								
			25		MOTTLED ORANGE AND BROWN GRAVEL WITH SAND (GP), Medium dense, wet, fine to coarse sand and gravel, some cobbles and boulders.								
			51+										
	5				Drilling Refusal at 4-1/2 feet. • Free water encountered at 1-1/2 feet.								
	10												
	15												
	20												

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LOG OF BORING B-12
Spring Lake Village East Grove
Highway 12 & Los Alamos Road
Santa Rosa, California

PLATE
14

Date(s) Drilled **1/24/2017**	Logged By **DAV**	Checked By **EGC**
Drilling Method **Hollow Stem Auger**	Drill Bit Size/Type **8-inch HSA**	Total Depth of Borehole **14-1/2 feet**
Drill Rig Type **CME-55 Track-Mounted**	Drilling Contractor **Taber Drilling**	Approximate Surface Elevation **Existing Ground Surface**
Groundwater Level and Date Measured **1 foot**	Sampling Method(s) **Modified California, SPT**	Hammer Data **140 lb, 30-inch autotrip**

Elevation (feet)	Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Graphic Log	MATERIAL DESCRIPTION	Dry Density (pcf)	Water Content (%)	% <#200 Sieve	PI, %	LL, %	Expansion Index (EI)	UC, ksf	REMARKS AND OTHER TESTS
	0				2" baserock.								
					LIGHT BROWN AND GRAY CLAYEY SAND (SC), Medium dense, moist, fine sand.								
			16					46.3	9	27	43		
			22										
	5												
			9		DARK BROWN AND GRAY CLAY WITH SAND (CL), Stiff, moist, fine to coarse sand, few gravels.								
					BROWN SAND WITH CLAY (SP-SC), Medium dense, wet, fine sand.								
					DARK BROWN AND BLUE GRAVEL SAND WITH GRAVEL (SC), Medium dense, wet, fine to coarse sand and gravel, few cobbles.								
	10		13					10.9					
			51+		GRAY-BLUE SAND WITH GRAVEL (SP), Very dense, moist, fine to coarse sand and gravel.								
	15				Drilling refusal at 14-1/2 feet. Free water encountered at 1 foot.								
	20												

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LOG OF BORING B-13

Spring Lake Village East Grove
Highway 12 & Los Alamos Road
Santa Rosa, California

PLATE 15

Elevation (feet)	Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Graphic Log	MATERIAL DESCRIPTION	Dry Density (pcf)	Water Content (%)	% <#200 Sieve	PI, %	LL, %	Expansion Index (EI)	UC, ksf	REMARKS AND OTHER TESTS
1	2	3	4	5	6	7	8	9	10	11	12	13	14

COLUMN DESCRIPTIONS

1 Elevation (feet): Elevation (MSL, feet).
2 Depth (feet): Depth in feet below the ground surface.
3 Sample Type: Type of soil sample collected at the depth interval shown.
4 Sampling Resistance, blows/ft: Number of blows to advance driven sampler one foot (or distance shown) beyond seating •interval using the hammer identified on the boring log.
5 Graphic Log: Graphic depiction of the subsurface material encountered.
6 MATERIAL DESCRIPTION: Description of material encountered. May include consistency, moisture, color, and •other descriptive text.
7 Dry Density (pcf): Dry density, in pcf.
8 Water Content (%): Water content, percent.
9 % <#200 Sieve: % <#200 Sieve
10 PI, %: Plasticity Index, expressed as a water content.
11 LL, %: Liquid Limit, expressed as a water content.
12 Expansion Index (EI): Expansion Index (EI)
13 UC, ksf: Unconfined compressive strength, in kips per square foot.
14 REMARKS AND •OTHER TESTS: Comments and observations regarding drilling or sampling made by driller or field •personnel.

FIELD AND LABORATORY TEST ABBREVIATIONS

CHEM: Chemical tests to assess corrosivity
COMP: Compaction test
CONS: One-dimensional consolidation test
LL: Liquid Limit, percent
PI: Plasticity Index, percent
SA: Sieve analysis (percent passing No. 200 Sieve)
UC: Unconfined compressive strength test, Qu, in ksf
WA: Wash sieve (percent passing No. 200 Sieve)

MATERIAL GRAPHIC SYMBOLS

Fat CLAY, CLAY w/SAND, SANDY CLAY (CH)
Lean CLAY, CLAY w/SAND, SANDY CLAY (CL)
Clayey GRAVEL (GC)
Poorly graded GRAVEL (GP)
Clayey SAND (SC)
Poorly graded SAND (SP)
Poorly graded SAND with Clay (SP-SC)

TYPICAL SAMPLER GRAPHIC SYMBOLS

3-inch-OD Modified California w/ brass liners

2½-inch-OD unlined split spoon (SPT)

OTHER GRAPHIC SYMBOLS

Water level (at time of drilling, ATD)
Water level (after waiting)
Minor change in material properties within a stratum
Inferred/gradational contact between strata
—?— Queried contact between strata

GENERAL NOTES

1: Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive, and actual lithologic changes may be gradual. Field descriptions may have been modified to reflect results of lab tests.
2: Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced. They are not warranted to be representative of subsurface conditions at other locations or times.

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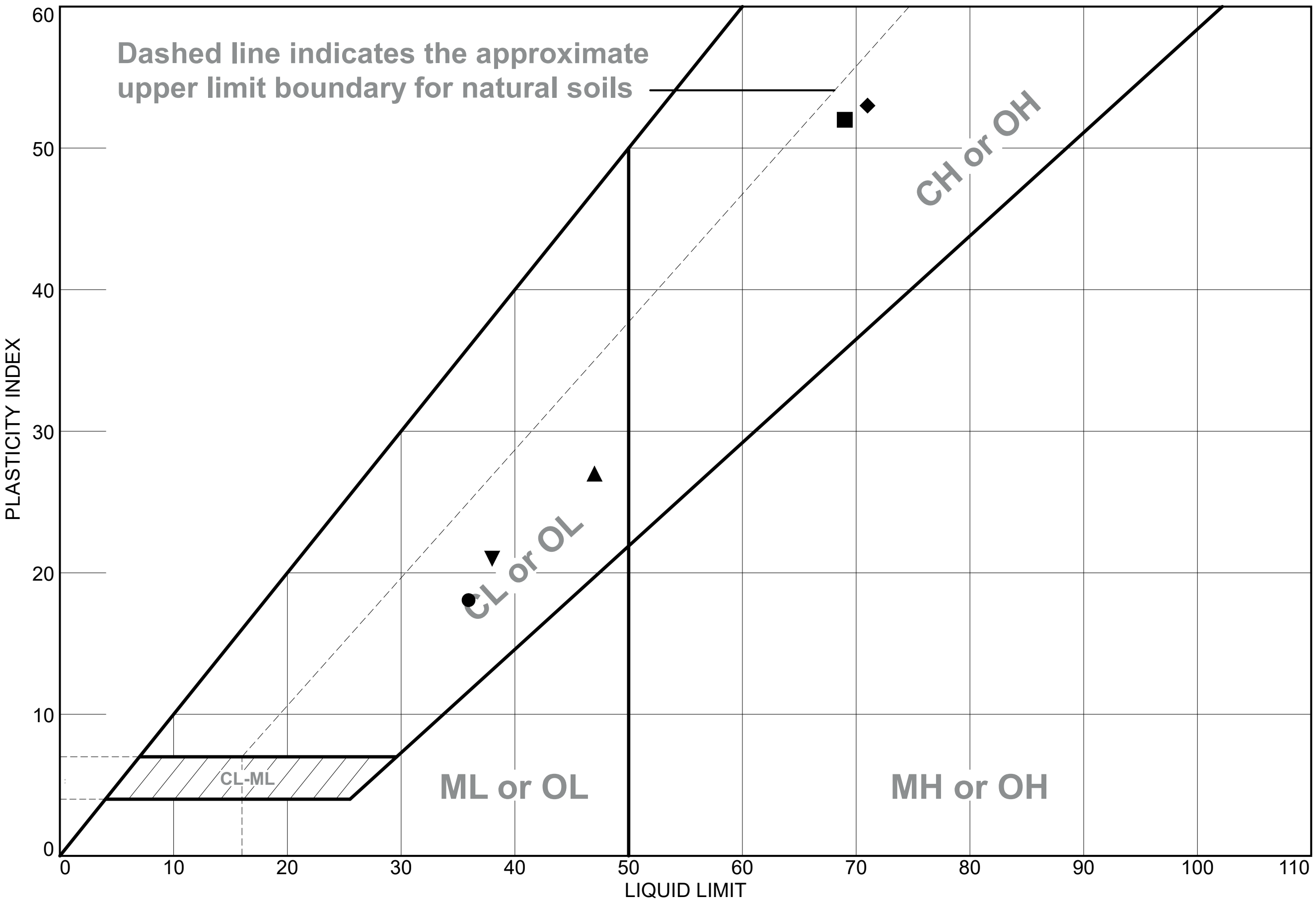
Job No: 2411.05.05.1 | Date: FEB 2017

SOIL CLASSIFICATION AND KEY TO TEST DATA
Spring Lake Village East Grove
Highway 12 & Los Alamos Road
Santa Rosa, California

PLATE 16

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Brn Clayey Sand (SC)	36	18	18		49.8	SC
■	Brn Sandy Clay W/ Gravel (CH)	69	17	52		54.0	CH
▲	Brn Sandy Clay (CL)	47	20	27		68.5	CL
◆	Brn Clay W/ Sand (CH)	71	18	53		76.6	CH
▼	Brn Clayey Sand (SC)	38	17	21		21.4	SC

Project No. 2411.05.04.1 **Client:** RGH Consultants

Project: Spring Lake Village East Grove

●**Source of Sample:** B-2 **Depth:** 2.5' & 3.0'
■**Source of Sample:** B-5 **Depth:** 2.0'
▲**Source of Sample:** B-7 **Depth:** 16.0'
◆**Source of Sample:** B-9 **Depth:** 1.5' & 2.0'
▼**Source of Sample:** B-8 **Depth:** 11.0'

Tested By: SW
Checked By: GEF

Remarks:
●Expansion Index=85
◆Expansion Index=153

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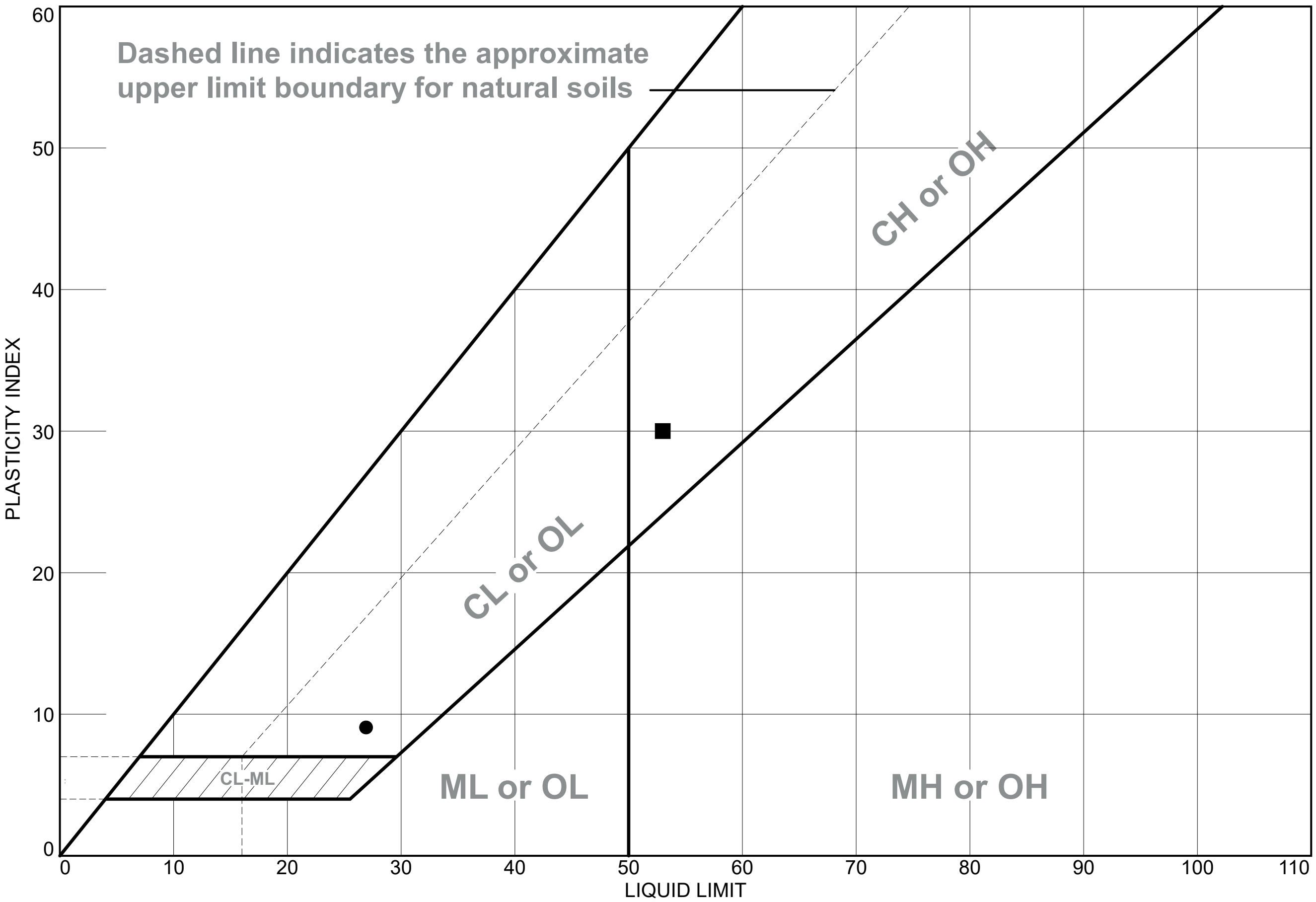
Job No: 2411.05.05.1 | Date: FEB 2017

CLASSIFICATION TEST DATA
Spring Lake Village East Grove
Highway 12 & Los Alamos Road
Santa Rosa, California

PLATE
17

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Grey Clayey Sand (SC)	27	18	9		46.3	SC
■	Brn Clayey Sand W/ Gravel (SC)	53	23	30		35.5	SC

Project No. 2411.05.05.1 **Client:** RGH Consultants

Project: Spring Lake Village East Grove

●**Source of Sample:** B-13 **Depth:** 1.5' & 2.0' **Sample Number:** Composite

■**Source of Sample:** B-10 **Depth:** 1.5' & 2.0' **Sample Number:** Composite

Tested By: SW
Checked By: GEF

Remarks:
●Expansion Index=43
■Expansion Index=48

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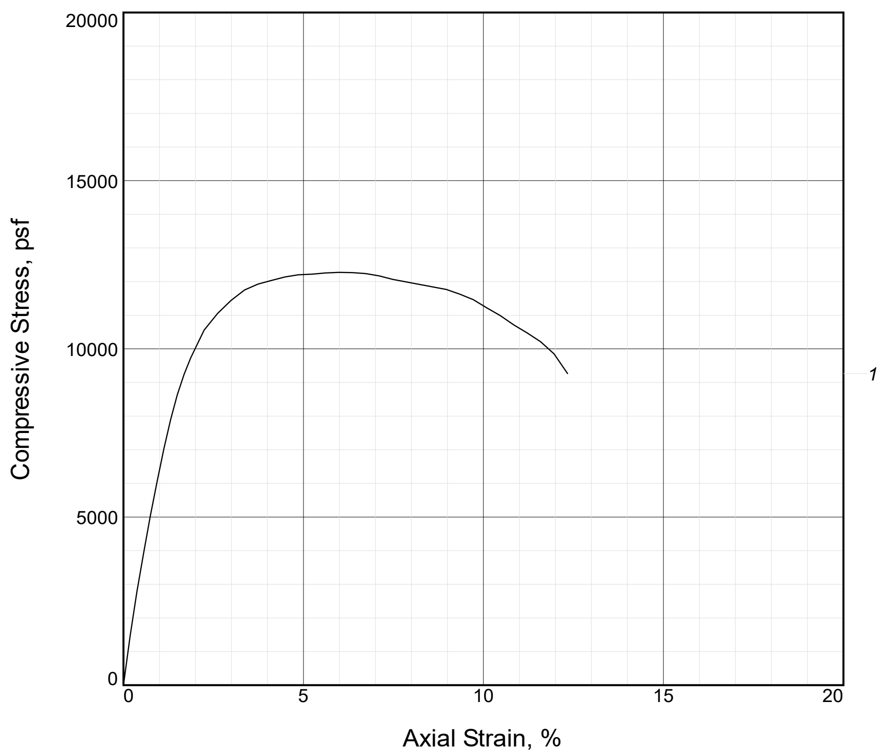
Job No: 2411.05.05.1 Date: FEB 2017

CLASSIFICATION TEST DATA

Spring Lake Village East Grove
Highway 12 & Los Alamos Road
Santa Rosa, California

PLATE **18**

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	12275			
Undrained shear strength, psf	6137			
Failure strain, %	6.0			
Strain rate, in./min.	0.060			
Water content, %	20.3			
Wet density, pcf	128.8			
Dry density, pcf	107.1			
Saturation, %	95.5			
Void ratio	0.5739			
Specimen diameter, in.	2.410			
Specimen height, in.	5.350			
Height/diameter ratio	2.22			

Description: Brn Clay W/ Sand (CH)

LL =	PL =	PI =	GS= 2.70	Type: Undisturbed

Project No.: 2411.05.04.1

Date Sampled: 12/22/14

Remarks:

Tested By: SW
Checked By: GEF

Client: RGH Consultants

Project: Spring Lake Village East Grove

Source of Sample: B-9 **Depth:** 1.5’

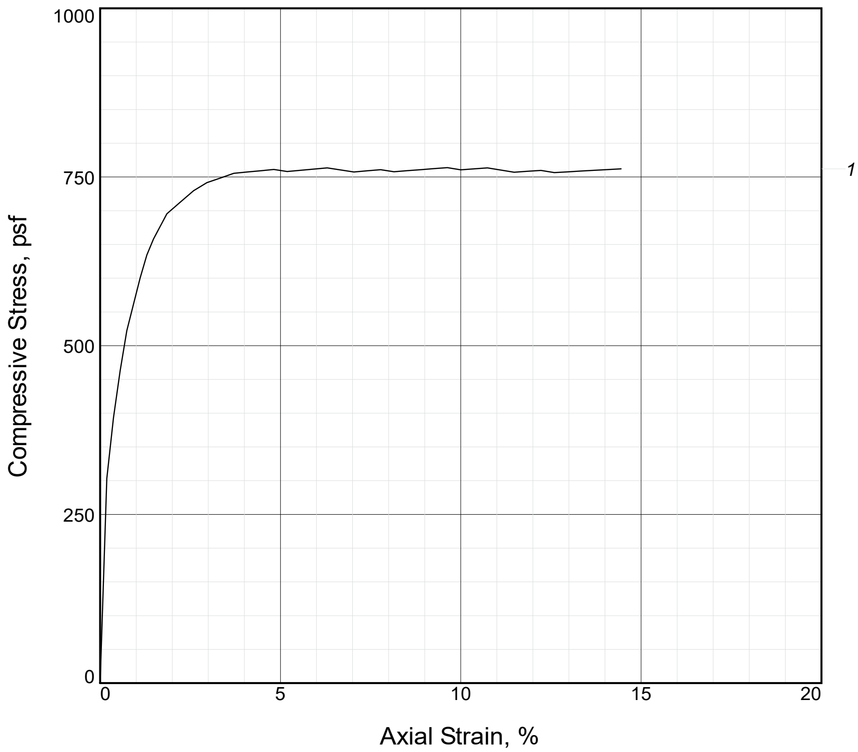
RGH CONSULTANTS

Job No: 2411.05.05.1 | Date: FEB 2017

STRENGTH TEST DATA
Spring Lake Village East Grove
Highway 12 & Los Alamos Road
Santa Rosa, California

PLATE
19

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	764			
Undrained shear strength, psf	382			
Failure strain, %	6.3			
Strain rate, in./min.	0.060			
Water content, %	31.4			
Wet density, pcf	119.8			
Dry density, pcf	91.1			
Saturation, %	99.9			
Void ratio	0.8496			
Specimen diameter, in.	2.400			
Specimen height, in.	5.400			
Height/diameter ratio	2.25			

Description: Brn Clay (CH)

LL =	PL =	PI =	GS= 2.70	Type: Undisturbed

Project No.: 2411.05.04.1

Date Sampled: 12/16/14

Remarks:

Tested By: SW
Checked By: GEF

Client: RGH Consultants

Project: Spring Lake Village East Grove

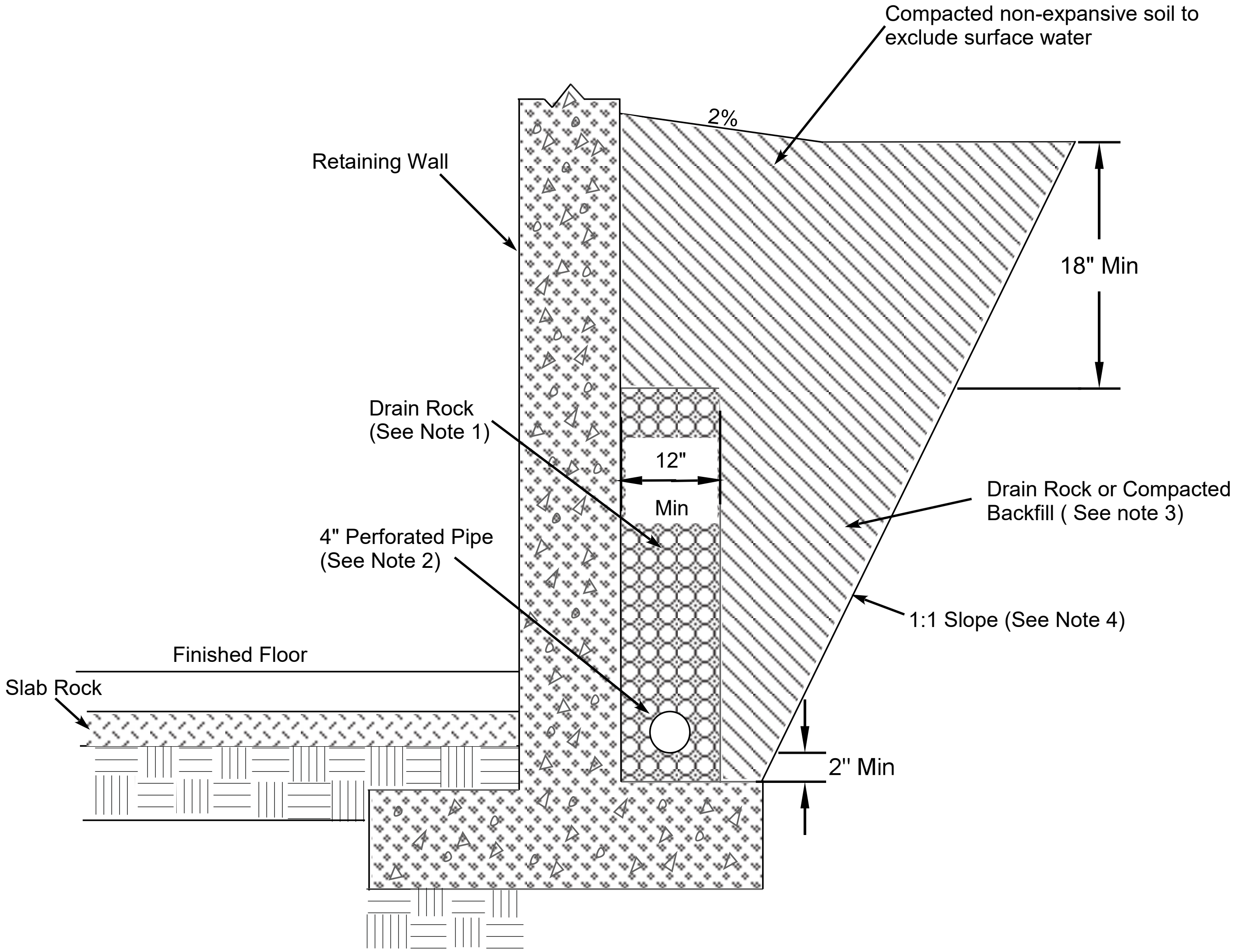
Source of Sample: B-9 **Depth:** 2.0'

RGH CONSULTANTS

Job No: 2411.05.05.1 | Date: FEB 2017

STRENGTH TEST DATA
Spring Lake Village East Grove
Highway 12 & Los Alamos Road
Santa Rosa, California

PLATE **20**



Notes:

1. Drain rock should meet the requirements for Class 2 Permeable Material, Section 68, State of California "Caltrans" Standard Specification, latest edition. Drain rock should be placed to approximately three-quarters the height of the retaining wall.

2. Pipe should conform to the requirements of Section 68 of State of California "Caltrans" Standards, perforations placed down, sloped at 1% for gravity flow to outlet or sump with automatic pump. The pipe invert should be located at least 8 inches below the lowest adjacent finished surface.

3. During construction the contractor should use appropriate methods such as temporary bracing and/or light compaction equipment to avoid overstressing the walls. Non-expansive soils to be used as backfill.

4. Slope excavation back at a 1:1 gradient from the back of footing where expansive materials are exposed.

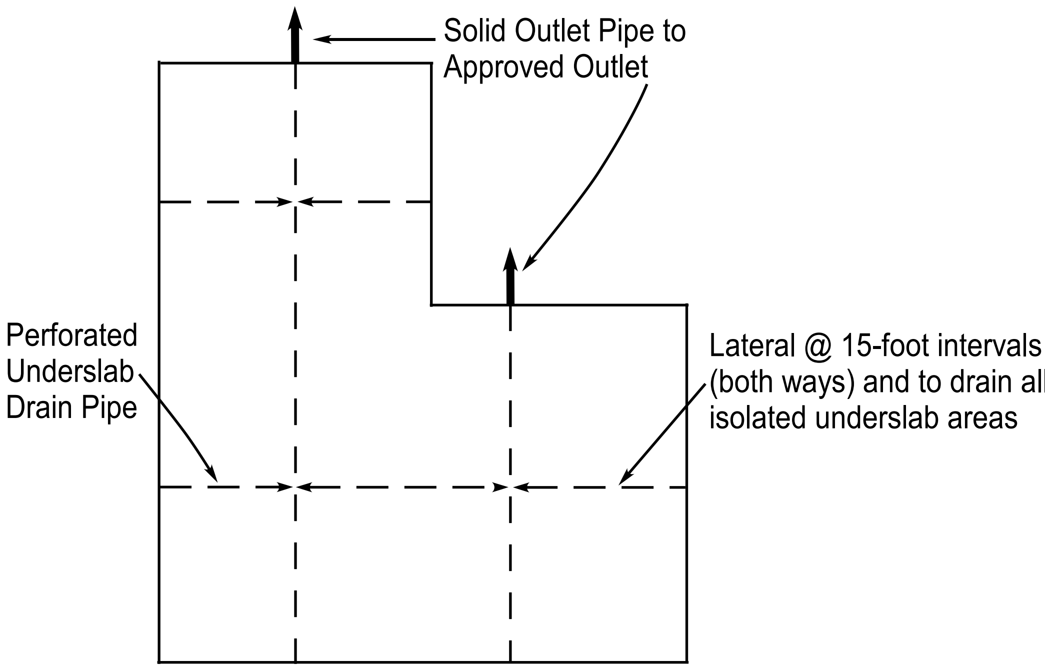
Not to Scale

RGH CONSULTANTS

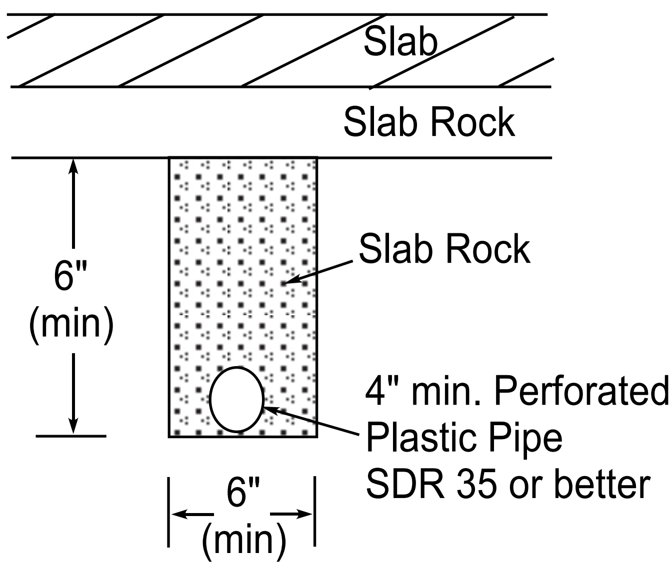
Job No: 2411.05.05.1 | Date: FEB 2017

RETAINING WALL BACKDRAIN ILLUSTRATION
Spring Lake Village East Grove
Highway 12 & Los Alamos Road
Santa Rosa, California

PLATE 21



TYPICAL UNDERSLAB DRAIN PLAN



SLAB UNDERDRAIN PROFILE

RGH CONSULTANTS

Job No: 2411.05.05.1 | Date: FEB 2017

TYPICAL SUBDRAIN DETAILS
Spring Lake Village East Grove
Highway 12 & Los Alamos Road
Santa Rosa, California

PLATE
22

APPENDIX B - REFERENCES

American Society of Civil Engineers, 2010, Minimum Design Loads for Buildings and Other Structures, ASCE Standard ASCE/SEI 7-10.

Bortugno, E.J., 1982, Map Showing Recency of Faulting, Santa Rosa Quadrangle in Wagner and Bortugno, Geologic Map of the Santa Rosa Quadrangle: California Division of Mines and Geology, Regional Geologic Map Series, Map No. 2A, Santa Rosa Quadrangle, Scale 1:250,000.

Bryant, W.A., and Hart, E.W., Interim Revision 2007, Fault-Rupture Zones in California; California Geological Survey, Special Publication 42, p. 21 with Appendices A through F.

California Building Code, 2016, California Building Standard Commission.

Dwyer, M.J., Noguchi, N., and O'Rourke, J., 1976, Reconnaissance Photo-Interpretation Map of Landslides in 24 Selected 7.5-Minute Quadrangles in Lake, Napa, Solano, and Sonoma Counties, California: U.S. Geological Survey OFR 76-74, 25 Plates, Scale 1:24,000.

Hansen, Kent, 2008, Porous Asphalt Pavements for Stormwater Management - Design, Construction, and Maintenance Guide, National Asphalt Pavement Association.

Huffman, M.E., and Armstrong, C.F, 1980, Geology for Planning in Sonoma County, California: California Division of Mines and Geology Special Report 120, 31 p., 5 plates.

Idriss, I.M. and Boulanger, R.W., 2004, Semi-Empirical Procedures for Evaluating Liquefaction Potential During Earthquakes, Proceedings of the 11th ICSDEE and 3rd ICEGE, pp. 32-56.

Idriss, I.M. and Boulanger, R.W., 2008, Soil Liquefaction During Earthquakes.

Ishihara, K., and Yoshimine, M., 1992, Evaluation of settlements in sand deposits following liquefaction during earthquakes, *Soils and Foundations* 32(1), 173-88.

McLaughlin, R.J., Langenheim, V.E., Sarna-Wojcicki, A.M., Flek, R.J., McPhee, D.K., Roberts, C.W., McCabe, C.A., and Wan, E., 2008, Geologic and Geophysical Framework of the Santa Rosa 7.5' Quadrangle, Sonoma County, California, U.S. Geological Survey, Open-File Report 2008-1009, 51 p., 3 plates, Scale 1:24,000.

Natural Resources Conservation Service, United States Department of Agriculture, accessed December 2014. Web Soil Survey, available online at http://websoilsurvey.nrcs.usda.gov/.

Petersen, et al., 1996, Probabilistic Seismic Hazard Assessment for the State of California, California Department of Conservation, Division of Mines and Geology, Open File Report 96-08.

Seed, H.B. and Idriss, I.M., 1982, Ground Motion and Soil Liquefaction During Earthquakes: Earthquake Engineering Research Institute, Berkeley, California.

Seed, H.B., Tokimatsu, K., Harder, L.F., and Chung, R.M., 1985, Influence of SPT Procedures in Soil Liquefaction Resistance Evaluations: Journal of Geotechnical Engineering Division, American Society of Civil Engineers, v. III, no. 12, December, p. 1425-1445.

Working Group on California Earthquake Probabilities, 2007, Uniform California Earthquake Rupture Forecast (UCERF): Notes on Southern California Earthquake Center (SCEC) Web Site (http://www.scec.org/ucerf/).

Youd, T.L., and Idriss, I.M., and 19 others, 2001, Liquefaction Resistance of Soils: summary report from the 1996 NCEER and 1998 NCEER/NSF workshops on evaluation of liquefaction resistance of soils: ASCE Geotechnical and Geoenvironmental Journal, v. 127, no. 10, p. 817-833.

APPENDIX C - DISTRIBUTION

Episcopal Senior Communities (1,0 and electronic)
Attention: Alex Dees
2185 North California Blvd., Suite 575
Walnut Creek, CA 94596
ADees@jtm-esc.org

Perkins Eastman (1,0 and electronic)
Attention: Gerard Schmidt
1100 Liberty Avenue
Pittsburgh, PA 15222
G.Schmidt@perkinseastman.com

Adobe Associates, Inc. (0,0, and electronic)
Attn: Dave Brown
Dbrown@dobeinc.com

EGC:JJP:bc:ec:ejw

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Appendix E – Groundwater Availability Study

March 13, 2020

Mr. Kevin Gerber
Covia
2185 North California Boulevard, Suite 575
Walnut Creek, CA 94596

RE: GROUNDWATER AVAILABILITY STUDY
225 LOS ALAMOS ROAD/5803 AND 5815 MELITA ROAD
SANTA ROSA, CALIFORNIA
EBA JOB No. 20-2849

Dear Mr. Gerber:

This report presents the results of a groundwater availability study (Study) conducted for the Spring Lake Village (SLV) properties located at 225 Los Alamos Road, and 5803 and 5815 Melita Road in Santa Rosa, California collectively referred to herein as the "project site" (see Figure 1, Appendix A for site location). The Study was prepared using guidance set forth in Policy WR-2e of the Sonoma County General Plan (SCGP). Please note that the project site is located in the City of Santa Rosa (City), is in a Zone 1 groundwater availability area as defined by the SCGP, (i.e., major groundwater basin) and will be serviced by the City municipal water system. Such projects are typically not subject to a groundwater availability analysis. However, the project proposes using an on-site water supply well(s) for landscape irrigation purposes and in the interest of due diligence and stewardship, SLV has opted to perform this Study as part of the development process.

The purpose of Policy WR-2e is to determine whether there are adequate existing and future groundwater supplies to accommodate the proposed development demands and to estimate the effects of drawdown, if any, within the designated cumulative impact area. This Study was prepared to meet these objectives.

1.0 BACKGROUND INFORMATION

1.1 Project Description

The project site consists of a 5.83-acre (AC) parcel, a 1.43 AC parcel and a 0.070 AC parcel identified as Assessor's Parcel Numbers (APNs) 031-101-026, 035 and -0.34. A site plan illustrating the general project site features is presented as Figure 2 (Appendix A). The 225 Los Alamos Road property consists of a vacant lot containing trees, shrubs and grassland. The 5803 and 5815 Melita Road properties currently contain a residence, a second unit, and a garage and outbuilding. Ground elevations across the project site range from approximately 320 to 350 feet above mean sea level (MSL).

The project site currently contains two 8-inch diameter water supply wells (identified herein as "WELL-225" and WELL-5815) located near Melita Road in the southwestern portions of the parcels (see Figure 2, Appendix A). WELL-225 is reportedly completed to a depth of approximately 52 feet below ground surface (BGS), and is constructed with steel casing. WELL-225 yielded 14 gallons per minute (GPM) during a limited test performed by Petersen Drilling and Pump on October 26, 2016. Depth to water at the time of EBA's site visit on September 20, 2016 was 7.40 feet below the top of the well casing (TOC) and prior to the pumping test (October 26, 2016) was 6.02 feet below the top of the casing. WELL-5815, in turn, is reportedly constructed to a depth of 65 feet BGS and its yield is unknown at this time. The depth to water at the time of EBA's January 13, 2017 site visit was measured to be 4.28 feet below the TOC.

In general, the proposed project (hereafter referred to as Modified Original plan) includes the construction of a senior living facility, infrastructure improvements, and new landscaping and trees. The Modified Original plan specifically consists of the following: ten (10) cottages (46,401 square feet [sf]), a 12-unit Villa (24,761 sf) and a community building (4,435 sf). These buildings will collectively encompass approximately 75,600 sf and also include miscellaneous support buildings (i.e., generator shed, maintenance shed, etc.). The proposed project will result in approximately 46 percent of the 7.33 AC site consisting of impervious surfaces including building footprints and paved surfaces.

1.2 Local Hydrogeology

The project site is located within the Santa Rosa Valley – Rincon Valley Subbasin (Groundwater Basin 1.055.03), a low priority basin as defined by the California Department of Water Resources (CDWR) in *Bulletin 118 Interim Update 2016* (CDWR, 2016). A geologic map presented in *Bulletin 118-4* (California Department of Water Resources [CDWR], 1975) indicates that the project site area is underlain by rocks associated with Quaternary Alluvium (Holocene). More recent mapping of the Santa Rosa and Kenwood Quadrangles conducted by the United States Geological Survey (USGS) and California Geologic Survey (CGS), respectively (McLaughlin et al, 2008 and DeLattre et al, 2007) provide greater detail of the units overlying the project site. These units from youngest to oldest include Quaternary (Holocene) channel deposits (Qhc), Quaternary (latest Pleistocene to Holocene) alluvial deposits (Qt), and Pliocene fluvial deposits (Tgp/QTu), and pumiceous ash flow deposit (Tsvt). The geology observed during EBA's site visit as well as the Water Well Drillers Reports (WWDRs) reviewed as part of the preparation of this Report was generally consistent with the USGS and CGS map findings.

A geologic map and cross section of the site vicinity is presented as Figures 3 and 4 (Appendix A). Figure 4 depicts the cross section associated with the USGS map (C' to C"). Please note that the project site is located approximately 2,000 feet east of the cross section trace but contains similar lithology as depicted on the cross section. According to the USGS and CGS maps, WELL-225 is completed in Qt and Tgp/QTu (alluvial, fluvial and lacustrine). Yields of groundwater to wells in such deposits can range from slight to moderate with specific yields ranging from eight to 17 percent (*Bulletin 118-4*, CDWR, 1975 and 1982). These materials may provide significant quantities of groundwater where appreciable thickness exists. Much of the groundwater yield in the hilly surrounding area towards the east has been attributed to the underlying Sonoma Volcanic rocks in areas where fracturing exists.

The most prominent surface water feature in proximity of the project site is Santa Rosa Creek, which is located approximately 150 feet southwest of the site. Surface water flow in the Santa Rosa Creek is to the west and is perennial in nature (Figure 2, Appendix A).

1.3 Local Climate

According to the Western Regional Climate Center (WRCC), rainfall at the nearest weather station with historical data is located northwest Santa Rosa. This weather station has data from 1925 through 2010 and includes average precipitation totals of approximately 30.1 inches per year (http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca7965). The mean annual potential evapotranspiration (ET_o) for the area is estimated to be approximately 42 inches per year (State of California, 2009).

2.0 RESEARCH

The following subsections provide a summary of the scope of research performed and the corresponding findings used to implement the groundwater availability study. The scope of the research was developed to comply with the Policy WR-2e guidelines.

2.1 Site Reconnaissance

EBA Engineering (EBA) conducted two site visits of the property on September 20, 2016 and January 13, 2017. The purpose of the site visits was to observe existing site features, site topography, local geology, etc. At the time of the two site visits, the project site was generally consistent with that described in Subsection 1.1 (*Project Description*) of this report. As previously noted, the depth to groundwater as measured in WELL-225 and WELL-5815 at the time of the site visits was 7.40 feet and 4.28 feet below the TOC, respectively (i.e., approximately 7 and 3.5 feet BGS, respectively). In addition, surface water flow was also observed in Santa Rosa Creek located to the south of the project site across Montgomery Drive.

Nearby developments and property uses were also observed during the reconnaissance. Please be advised that due to the limited public access, visual observations were confined to what could be seen from the property and public access roads. The project site is bordered to the northeast by Highway 12, the northwest by the Hope Chapel and residential properties, the southeast by residential properties, and southwest by Melita Road. The ground elevations slope from the north towards the southwest.

Several off-site water supply wells were visually identified in proximity of the project site. These wells were primarily located along Melita Road, the nearest of which was assumed to be approximately 100 feet east from WELL-225 (Figure 2, Appendix A).

The site reconnaissance was supplemented with review of Google Earth Pro aerial imagery for the area. EBA also utilized the web service Parcel Quest and City of Santa Rosa GIS services to assess the use of all parcels located in the cumulative impact area (discussed later in Section 3.0). Findings from this research were generally consistent with the above descriptions. Additional features identified within the cumulative impact area from the aerial imagery included several developed residential parcels. These sources also provided information that was used for the cumulative impact area water usage and water budget calculations.

2.2 Water Well Drillers Reports (WWDRs)

WWDRs maintained by CDWR were reviewed to obtain pertinent information for the area regarding water supply use, well completion depths, yields, etc. The scope of the CDWR research encompassed available records for wells located within Sections 9, 16 and 17 of Township 7 North (T7N), Range 7 West (R7W), Mount Diablo Baseline and Meridian. The off-site search radius was set at approximately one-half mile from the project site property boundary as a means of obtaining available information representative of the local hydrogeologic conditions. The results of this research identified 84 WWDRs or boreholes (multiple logs for some properties) (see Figure 2, Appendix A). Please note that Figure 2 also shows wells that were identified during the site reconnaissance and not necessarily confirmed with a WWDR. Of these 84 WWDRs, 35 were used in this evaluation based on their completion in Quaternary alluvium (i.e., consistent with WELL-225 and WELL-5815).

The following breakdown provides a summary of the well/borehole and water supply characteristics as described in the selected WWDRs:

TABLE 1 **RESULTS FROM WWDR RESEARCH AND SITE RECONNAISSANCE**		
Description	***On-Site***	***Off-Site***
Number of Water Supply Wells	2(1)	35
Drilling Depths (feet BGS)	52 and 65(2)	50 to 453
Static Groundwater Levels (feet BGS)	7.40, 6.02 and 4.28(3, 4)	5 to 105
Reported Yields (GPM)	15	5 to 37
Specific Capacity (GPM/ft)(5)	0.99	0.03 to 0.95(6)

WWDR: Water Well Driller's Report
BGS: Below Ground Surface
GPM: Gallons per Minute
GPM/ft: Gallons per Minute per Foot of Drawdown

(1): WELL-225 and WELL-5815.

(2): As reported by Peterson Drilling and Pump and property owner.

(3): Depth to water from top of casing.

(4): Measured on September 20, October 26, 2016 and January 13, 2017, respectively.

(5): Calculation includes a 20 percent correction factor for drawdown to account for inherent inefficiencies associated with air lift testing methods.

(6): Based on available information from 35 WWDRs.

Please note that the breakdowns provided in Table 1 should be considered estimates based on interpretation of the WWDR information.

2.3 Assessor's Parcel Maps

County of Sonoma assessor's parcel maps for the area were reviewed to assist in identifying neighboring property boundaries and addresses. This information, in turn, was used to establish the number of properties within the designated cumulative impact area that use groundwater as their primary water source (discussed in Section 3.0) for this study. Findings from this exercise identified 96 properties (including the project site) ranging in size from approximately less than one AC to 17 AC. Of these 96 properties, well/borehole information was identified for 23 properties within the cumulative impact area as determined from the WWDRs.

2.4 Zoning Information

Zoning designation records maintained by County of Sonoma – Permit and Resource Management Department (CS-PRMD) and City of Santa Rosa were reviewed for neighboring properties within the designated cumulative impact area to evaluate potential future uses and implications of the proposed project on future groundwater use in these areas. Findings from this research revealed that the project site is zoned Rural Residential 40 SR (RR 40 SR) per the City of Santa Rosa Zoning Code. The RR 40 SR zoning designation is intended to:

> *"The RR zoning district is applied to areas of the City intended to accommodate residential neighborhoods with compatible agricultural uses, but where the primary uses are residential, and compatible accessory uses. The maximum allowable density ranges from 0.2 to two dwellings per acre, with the specific allowable density for each parcel shown on the zoning map by a numerical suffix to the RR map symbol (see Section 20-22.040). The RR zoning district implements and is consistent with the Residential—Very Low Density land use classification of the* Santa Rosa *General Plan."*

> *"The SR combining district is intended to enhance and preserve the natural and constructed features that contribute to the character of scenic roads. Natural and constructed features include trees, rock walls, view corridors, road configuration and tree canopy."*

The properties bordering the site are within the City of Santa Rosa and have been subdivided into residential parcels and are serviced by municipal water supplies. The surrounding area has several zoning designations including City of Santa Rosa Planned Development (PD) and County of Sonoma Rural Residential B6 20 (RR B6 20). The properties north of the project site are mixed City of Santa Rosa and County RR B6 20.

With regard to zoning density, Combining Districts for the County specifying residential density and/or minimum parcel or lot size for the parcels, lots and/or the area includes B6. The B6 district designation specifies maximum permitted densities between 1.5 and 20 AC per dwelling unless public water serves the lot in which case the minimum is one AC per dwelling.

2.5 Well Yield Certification Tests

No well yield certification tests were available for WELL-225 or WELL-5815. However, on October 26, 2016, Petersen Drilling and Pump conducted a limited pumping test on WELL-225. A copy of the Test Pump Log is included in Appendix B of this Study. Prior to the test, EBA installed a pressure transducer in WELL-225 to record water level measurements prior to, during (drawdown) and following (recovery) the test. The data from the test was used to estimate the approximate yield of WELL-225 and calculate the transmissivity and storage coefficient of the aquifer to estimate drawdown in the area of WELL-225 from the proposed use of the well.

2.6 Documentation of Expended Effort

Approximately 40 hours have been expended in identifying existing wells within the area of interest, as well as other pertinent information with respect to the local hydrogeologic conditions, property uses, and determination of aquifer characteristics. This estimate reflects the cumulative time expended by EBA in researching the information (i.e., site reconnaissance, literature searches, interviews, and telephone calls) and performance of various calculations.

3.0 CUMULATIVE IMPACT AREA

The definition of "cumulative impact area" corresponds to the change in a specific area resulting from the incremental impact of the project when added to other closely related past, present, and reasonably foreseeable future projects. Based on this criterion, existing and future site development characteristics and zoning designations for surrounding properties were considered, coupled with the site hydrogeology and the nature of the proposed development, to estimate the cumulative impact area for the project.

An important consideration in establishing the cumulative impact area for this project is the local topography and hydrogeology. In this regard, the northwestern, northern and northeastern boundaries of the cumulative impact area are delineated by topographic ridges that define the local watersheds for the drainages that traverse from northeast to southwest across the northeastern portion of the project site. The southeastern and southern boundary of the cumulative impact area was aligned with Santa Rosa Creek. Please refer to Figure 2 (Appendix A) for an illustration of the established cumulative impact area as defined above. The overall size of the cumulative impact area is approximately 317 AC (including the project site).

Based on the geologic map for the area (see Figure 3, Appendix A), it is estimated that the majority of the cumulative impact area is underlain by alluvial, fluvial and lacustrine deposits. Consequently, these aquifer characteristics were utilized for the entire area in the analyses as presented in the following sections.

4.0 SUMMARY OF EXISTING / PROJECTED GROUNDWATER USE

Table 2 provides a general synopsis of both the existing and projected groundwater uses associated with the proposed development, as well as estimates of the off-site groundwater use on adjoining and nearby properties located within the cumulative impact area. The groundwater use information for the SLV property was provided by GHD. As previously noted, the domestic water demands for the project will be supplied by the City municipal water system. Thus, the on-site groundwater use will be limited to landscape irrigation for the proposed development plans (Modified Original). Please note that a portion of the off-site properties (i.e., Skyhawk subdivision, etc.) are supplied by City municipal water and were not included in the following analysis. The off-site groundwater use was estimated by EBA using industry standard values for domestic/incidental use.

As part of EBA's analysis, the website Parcel Quest was utilized to determine the number of bedrooms associated with existing dwellings. In regards to future development, 3-bedroom dwellings were assumed for those properties in which an existing dwelling was not identified by Parcel Quest or parcels that could be subdivided in the future.

TABLE 2 SUMMARY OF EXISTING / PROJECTED GROUNDWATER USE			
Description	**Existing (AF/yr)**	**Future Additional (AF/yr)**	**Future Combined (AF/yr)**
Spring Lake Village Groundwater Use			
Landscape Irrigation(1)	0.00	2.93	2.93
Spring Lake Village Totals	***0.00***	***2.93***	***2.93***
Off-Site Groundwater Use			
Single Family Dwellings – Domestic Use(4)	64.50	10.50	75.00
Single Family Dwellings – Incidental Use(5)	20.50	3.50	24.00
Off-Site Totals	***85.00***	***14.00***	***99.00***
Combined Groundwater Use			
Combined Totals	***85.00***	***16.93***	***101.93***

AF/yr: Acre-Feet per Year

(1) Increase due to landscape irrigation only.

(2) Based on 258 existing bedrooms and 42 future additional bedrooms at an incremental water use of 0.25 AF/yr per bedroom.

(3) Based on 82 existing dwellings and 14 future additional dwellings at an incremental water use of 0.25 AF/yr per dwelling.

It should be noted that the projected groundwater use estimates presented above correspond to the irrigation demand for the established landscaping at the project site under the two scenarios. The initial groundwater use is expected to be higher during the first year as the landscaping is first planted and will diminish as the vegetation matures. Based on the analysis performed in this Study, the existing groundwater supply is sufficient to meet these initial higher demands.

5.0 GROUNDWATER AVAILABILITY ANALYSIS

As outlined in the introduction of this report, the primary objectives of the groundwater availability analysis were to evaluate whether there are adequate existing and future groundwater supplies to accommodate the proposed project and to estimate the effects of drawdown within the designated cumulative impact area. The following subsections address each of these issues.

5.1 Water Supply Capabilities

Groundwater in Storage

The volume of water in storage within the cumulative impact area was estimated by multiplying the volume of the aquifer by its specific yield. It was assumed that the entire area (317 AC) is underlain by alluvium and Pliocene fluvial and lacustrine deposits. The aquifer thickness was based on the average static groundwater level recorded in the WWDRs and the average aquifer depth, which was set at the average depth of the water supply wells identified. This value was used based on the wide range of water supply well depths (50 to 453 feet BGS) that were identified in the preparation of this Study. Please note that the 453-foot deep well was removed from the calculations as a conservative measure because it was anomalously deep when compared with the remaining WWDRs. Finally, the aquifer's specific yield or secondary porosity volume was based on literature values (Bulletin 118-4 [CDWR, 1982]). Using this information, the storage capacity for the aquifer was calculated by multiplying the respective variables.

The following provides a breakdown of the calculations:

- Aquifer Area: 317 AC
- Average Static Groundwater Level: 40 feet BGS
- Maximum Aquifer Depth: 181 feet BGS
- Aquifer Thickness: 141 feet
- Specific Yield: 25 percent
- Calculated Volume of Water in Storage: 11,174 acre-feet (AF)

Based on the above calculations, the estimated volume of water in storage within the cumulative impact area equates to 11,174 AF. As presented in Section 4.0 (*Summary of Existing/Projected Groundwater Use*), the additional groundwater supply requirements for the proposed development plans are 2.93 acre-feet per year (AF/yr). These additional groundwater supply demand scenarios represent a negligible amount of the groundwater in storage within the cumulative impact area. Similarly, when considering the projected existing and future groundwater supply demand for the site (2.93 AF/yr), the corresponding water use equates to approximately 0.03 percent of the total groundwater in storage.

Water Budget

A water budget analysis was performed by comparing groundwater recharge characteristics to the projected on-site groundwater use over a given calendar year. In this regard, the groundwater recharge estimate for the cumulative impact area was calculated by assuming that precipitation represents the primary source of potential inflow into the underlying aquifer, and run-off, evapotranspiration, and evaporation represent the primary outflow variables. Whereas other secondary sources of inflow (i.e., groundwater inflow from upgradient boundaries, recharge from irrigation, etc.) and outflow (i.e., groundwater outflow along downgradient boundaries, discharge from surface springs, etc.) contribute to the overall groundwater recharge characteristics, these secondary sources were assumed to be relatively equal, resulting in no net gain or loss. Based on this approach, the following equation was used to calculate potential groundwater recharge:

$$\text{Groundwater Recharge} = P - (R + ET_a + E_{CI})$$

where "P" is equal to precipitation (in AF), "R" is equal to run-off (in AF), "ET_a" is equal to actual evapotranspiration (in AF), and "E_{CI}" is equal to evaporative losses related to canopy interception (in AF). Details regarding the calculation of each of these variables are presented below.

Precipitation (P)

The total volume of precipitation that falls within the cumulative impact area was calculated by multiplying the average annual precipitation rate (30.1) by the size of the cumulative impact area (317 AC).

Run-off (R)

The percentage of the total annual precipitation that results as outflow (i.e., run-off) was estimated by comparing the ground slopes within the cumulative impact area to run-off coefficients (RCs) for various types of developed and natural settings (ODOT, 2014). In general, slope surfaces were separated by areas identified as "flat" (less than 2 percent), "rolling" (2 to 10 percent) and "hilly" (greater than 10 percent). In this regard, the relative percentages of slopes within the cumulative impact area that align with these categories are approximately 0, 22 and 78 percent, respectively. These areas, in turn, were further separated by the types of settings. The following provides a breakdown of the setting types and range of RCs used in the analysis:

- Meadows / Pasture Land: 109 AC (RCs = 0.25 to 0.35)
- Dense Residential (6 to 15 Units/AC): 172 AC (RCs = 0.70 to 0.80)
- Woodland / Forest: 36 AC (RCs = 0.10 to 0.20)

Using the aforementioned variables, the annual run-off volume for each area was calculated by multiplying the respective areas by the annual precipitation volume, followed by multiplying the corresponding products by the applicable RC. The summation of all the area run-off volumes equates to the total annual run-off volume for the entire cumulative impact area.

Actual Evapotranspiration (ET_a)

As previously noted in Subsection 1.3 (*Local Climate*), the mean annual potential evapotranspiration (ET_o) for the area is estimated to be 42 inches per year. The ET_a, in turn, was calculated using a Water Use Classification of Landscape Species site specific model as described in *A Guide to Estimating Irrigation Water Needs of Landscape Plantings in California* (UC Cooperative Extension/California Department of Water Resources, 2000). The Water Use Classification of Landscape Species model allowed for estimation of ET_a for the vineyards, orchards and native vegetation within the WSA groundwater source area. In the case of areas occupied by vineyards, ET_a was only calculated for the rainy season (October through March) as any ET_a occurring during the dry season (April through September) is offset by irrigation, the volume of which is already accounted for as part of the water use calculations. In addition, it was assumed that no ET_a occurs for seasonal grasses over the period of July through September as these grasses are typically dead over this time frame.

Canopy Interception (CI)

Canopy interception corresponds to the fraction of rainfall that is intercepted by the canopy of trees and shrubs (assumed to be negligible for grassland areas) and subsequently lost to evaporation. This fraction was estimated using equations developed by Helvey and Patric (1965) that utilize gross rainfall, throughput (i.e., rainfall that reaches the ground through spaces in the vegetative canopy and as drip from leaves, twigs and stems), and stemflow (i.e., rainfall that is caught on the canopy and reaches the ground by running down stems) variables. The calculation excluded grassland and vineyard areas as the fraction of canopy interception for these areas is assumed to be negligible. With that being said, all other areas within the cumulative impact area were assumed to be subject to canopy interception losses.

The results of the water budget calculations using the aforementioned parameters are presented in Table 3.

TABLE 3
SUMMARY OF WATER BUDGET CALCULATIONS

Description	***Average (AF)***
Precipitation (inflow)	+795
Run-Off (outflow)	-449
Actual Evapotranspiration (outflow)	-87
Canopy Interception (outflow)	-5
Total	***+254***

AF: Acre-Feet

As presented in Table 3, the estimated volume of water potentially available for groundwater recharge during and average rainfall year is approximately 254 AF. Based on the estimated increase in groundwater use of 2.93 AF for the proposed development plans, this additional groundwater use only equates to approximately one percent of the water potentially available for recharge within the cumulative impact area. As for the total estimated future groundwater supply requirement (existing plus future development) within the cumulative impact area (101.93 AF/yr), this volume equates to approximately 40 percent of the water potentially available for recharge for each development plan scenario.

5.2 Drawdown Characteristics

Projected drawdown characteristics associated with the proposed project was estimated through the performance of a preliminary analysis using site-specific usage rates, data from the limited pumping test conducted for WELL-225 on October 26, 2016, and an analytical computer model. Because the project site is currently undeveloped, this evaluation focuses on the potential drawdown from the proposed project water use. The following subsections provide a summary of the various parameters considered in the analysis and the corresponding results.

Daily Water Demand

In accordance with the estimates outlined earlier, the projected total annual groundwater use for the proposed Modified Original plan is 2.93 AF/yr. This equates to a daily water demand of 2,616 gallons per day (GPD) when averaged over the entire year. However, it is assumed that this daily water demand will vary seasonally, with most of the water use occurring during the summer and early fall. For the purpose of calculating the maximum daily water demand for each scenario, it was conservatively assumed that all the water use will occur over a 153-day period (i.e. May through September). Based on this assumption, the maximum daily water demand equates to 6,240 GPD for the Modified Original plan.

Pumping Rate and Duration

Whereas the water demand scenario would likely occur intermittently throughout the day, the respective total volume was assumed to be pumped at one time as a conservative measure to induce the maximum potential drawdown characteristics. During the October 26, 2016 pumping event, WELL-225 was pumped at a rate of about 14 GPM for an eight-hour period (approximately 6,700 gallons). Findings from this exercise indicated that WELL-225 is capable of sustaining this rate for at least an eight-hour period. Based on this pumping rate in WELL-225, the pumping duration required to meet the daily water demand is approximately 7.4 hours. It should be noted that WELL-5815 is expected to exhibit a similar yield as WELL-225 based on its location, static water level and construction. However, for the purposes of this evaluation the analysis presented above assumes that WELL-225 is the sole source of irrigation water for the project site.

Aquifer Transmissivity

Determination of aquifer transmissivity for modeling purposes was accomplished using available data from limited pumping test for WELL-225. The recovery data collected following the pumping event was plotted versus a time ratio and transmissivity was calculated using the following equation:

$$T = \frac{264Q}{\Delta s}$$

for an unconfined aquifer, where "Q" is discharge rate (GPM), "Δs" is feet of recovery in the well, and "T" is transmissivity in GPD/ft. For the purpose of this analysis, the aquifer is assumed to be unconfined based on the lithology at the site and the cumulative impact area. The corresponding results from the calculation reveal a transmissivity value of approximately 4,000 GPD/ft.

Aquifer Storage Coefficient

A site-specific aquifer storage coefficient was estimated using a time-versus-drawdown analytical computer model as described later in this subsection for the determination of well interference characteristics. In essence, a pumping test was simulated using the analytical computer model and the transmissivity value (4,000 GPD/ft). Using a pumping rate (14 GPM) and the pumping duration (480 minutes), the aquifer storage coefficient variable in the model was adjusted until the predicted drawdown matched the actual drawdown from the pumping test. The findings from this exercise yielded an aquifer storage coefficient value of 0.25.

Well Interference Characteristics

The evaluation of well interference was conducted utilizing a time-versus-drawdown analytical computer model. Given a discharge rate and estimates of aquifer characteristics, the analytical model predicts groundwater drawdown as a function of distance from a pumping well. For this study, the classic nonequilibrium equation of Theis (1935) and the modified nonequilibrium equation of Jacob (1946) were used as the basis of our analysis.

The following input parameters were used in the analytical model:

- *Pumping Rate:* 14 GPM
- *Aquifer Transmissivity:* 4,000 GPD/ft
- *Aquifer Storage Coefficient:* 0.25
- *Pumping Durations:* 446 minutes (i.e., 7.4 hours)

Based on this characteristic, and the location of the nearest existing water supply well (located approximately 100 feet to the east) (see Figure 2, Appendix A), it appears that drawdown will not be induced at this location as a result of the pumping scenarios presented above. The analytical model indicates that the induced drawdown should be minimal, on the order of less than one foot approximately 50 feet from the pumping well, however, seasonal variations and rate and volume of groundwater extraction (from one or both wells) may affect the magnitude of the predicted influence. It should be noted that WELL-5815 is reportedly 65 feet deep (verbal conversation with owner and pump company on November 10, 2016), which is comparable in depth to WELL-225.

A well log was identified for the neighboring property to the east. The exact location of this well is unknown; however, the depth of the well, as reported on the WWDR, is approximately 150 feet deep. Given that WELL-225 is approximately 90 feet shallower than the adjacent well, it is unlikely that pumping from WELL-225 and WELL-5815 will have a significant influence on this adjacent well.

6.0 CONCLUSIONS

Based on the proposed water use and the estimates presented herein, it does not appear that the proposed project will have a significant impact on current and future groundwater availability at the project site or adjacent parcels, nor within the cumulative impact area under existing or foreseeable future use conditions. This conclusion is based on the following:

- The projected estimated annual groundwater supply requirement for the proposed development and existing uses (2.93 AF) equates to less than one percent of the groundwater in storage within the cumulative impact area and is significantly less than the amount of potential annual groundwater recharge (254 AF) for an average rainfall year.

- The SLV site and WELL-225 and WELL-5815 are located at the southern extent and furthest downgradient boundary of the cumulative impact area.

It is important to note that some influence in the groundwater elevations adjacent to WELL-225 and WELL-5815 should be expected, although such influences may be temporal in nature. The amount of influence can be minimized through the employment of water management practices.

7.0 SURFACE WATER / AQUATIC HABITAT

Policy WR-2e requires that the scope of the groundwater assessment encompass potential impacts to surface waters and aquatic habitats. As previously mentioned, the most prominent surface water feature in proximity of the project site is Santa Rosa Creek, which is located approximately 150 feet southwest of WELL-225 and WELL-5815. Given the results from the aforementioned analytical model, it does not appear that drawdown from pumping WELL-225 and/or WELL-5815 will extend to Santa Rosa Creek.

In addition, EBA evaluated potential streamflow depletion using USGS STRMDEPL08. Based on previous shallow drilling performed by EBA at a nearby site, it can be inferred that the upper 35 feet below ground surface of the area are primarily clays with some sandier layers. The WWDR's reviewed for this Study also confirm the presence of clay in the shallower depths. Based on this information, EBA used the equation derived by Hunt (Hunt, 1999) in which Santa Rosa Creek would be considered a "partially penetrating stream with streambed resistance". In other words, the streambed would only be partially penetrating the aquifer and the streambed would have some resistance between the aquifer and the surface water. The streambed conductance was set at 0.283 feet per day (10^{-4} centimeters per second) or that of a silty sand instead of 10^{-6} for clay for the purpose of being conservative. The model assumes isotropic qualities of the aquifer and continuous pumping at 14 gpm for a full day (1,440 minutes) with no recovery. As a matter of reference, the proposed groundwater use at the project site was 14 gpm for a period of 446 minutes. The remaining aforementioned parameters from the pumping test (i.e., transmissivity, storage coefficient) were utilized for the remaining variables. A result of the modeling suggests no stream depletion (0.0000 cubic foot per second) at a distance of 150 feet from the pumping well.

8.0 LIMITATIONS

This report was prepared in accordance with generally accepted standards of professional hydrogeologic consulting principles and practices at the place and time this study was performed. This warranty is in lieu of all other warranties, either expressed or implied. The conclusions presented herein are based solely on information made available to us by others, and includes professional interpretations based on limited research and data. Based on these circumstances, the decision to conduct additional investigative work to substantiate the findings and conclusions presented herein is the sole responsibility of the Client. This report has been prepared solely for the Client and any reliance on this report by third parties shall be at such party's sole risk.

9.0 CLOSING

EBA appreciates the opportunity to be of service to Covia on this project. If you should have any questions regarding the information contained herein, please do not hesitate to contact our office at (707) 544-0784.

Sincerely,
EBA ENGINEERING

Matthew J Earnshaw, P.G., C.Hg. QSD
Vice President - Senior Geologist

CERTIFIED HYDROGEOLOGIST
Matthew J. Earnshaw
947
STATE OF CALIFORNIA

Appendices: Appendix A - Figures
Appendix B - Petersen Drilling and Pump – Test Pump Log

9.0 REFERENCES

California Department of Water Resources, December 1975, *Evaluation of Ground Water Resources, Sonoma County, Volume 1: Geologic and Hydrologic Data;* Bulletin 118-4.

California Department of Water Resources, September 1982, *Evaluation of Ground Water Resources, Sonoma County, Volume 2: Santa Rosa Plain;* Bulletin 118-4.

California Department of Water Resources (CDWR), *2016 Bulletin 118 Interim Update*, CDWR December 22, 2016.

DeLattre, Wagner, Higgins, Witter, and Sowers, 2007, Geologic Map of the Kenwood 7.5' Quadrangle, Sonoma and Napa Counties, California, California Geologic Survey.

Driscoll F.G, 1986, *Groundwater and Wells,* Johnson Screens, Second Edition, St. Paul, MN.

Helvey, J.D. and Patric, J.H., 1965, *Canopy and Litter Interception of Rainfall by Hardwoods of Eastern United States;* Water Resources Research, Volume 1, Number 2, Second Quarter, p. 193-205.

Hunt, Bruce, 1999, Unsteady stream depletion from ground water pumping: Ground Water, v. 37, no. 1, pp. 98-102.

Jacob, C.E., 1946, *Drawdown Test to Determine Effective Radius of Artesian Well: Transactions,* Am. Soc. Civil Engineers, Vol. 112, p. 1047-1070.

McLaughlin et al, 2008, Geologic and Geophysical Map of the Santa Rosa 7.5' Quadrangle, Sonoma County, California, United States Geologic Survey.

Oregon Department of Transportation, Highway Division, April 2014, *Hydraulics Design Manual, Appendix F;* Prepared by Engineering and Asset Management Unit, Geo-Environmental Section.

State of California, September 10, 2009, *California Code of Regulations, Title 23, Division 2, Chapter 2.7 – Model Water Efficient Landscape Ordinance, Appendix A – Reference Evapotranspiration (ETo) Table*.

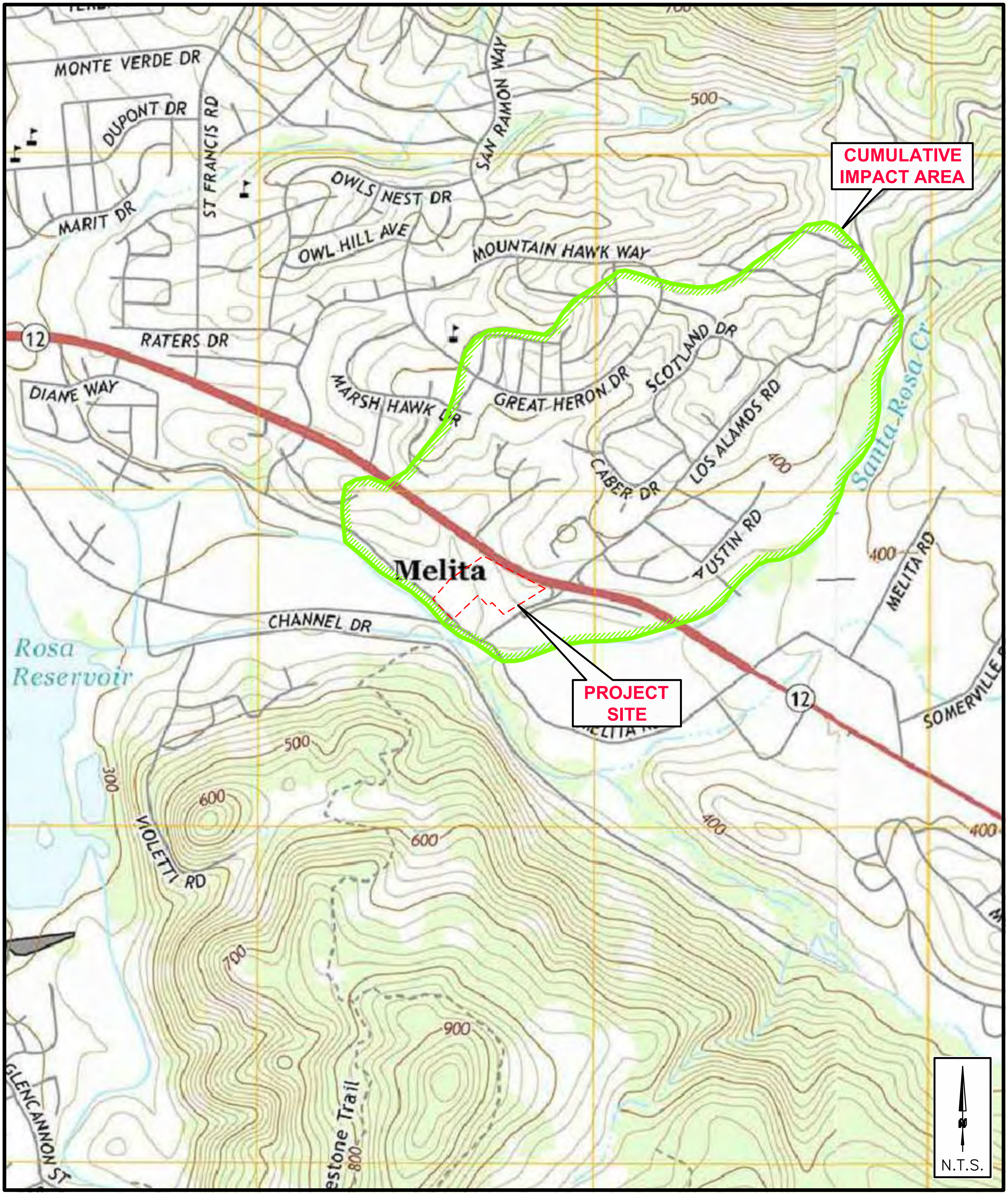
Theis, C.V., 1935, *The Relation between the Lowering of the Piezometric Surface and the Rate and Duration of Discharge of a Well Using Ground Water Storage: transactions,* Am. Geophysical Union, Washington, D.C. p. 518-524.

Western Regional Climate Center (WRCC) (http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca7965)

UC Cooperative Extension, California Department of Water Resources, August 2000, *A Guide to Estimating Irrigation Water Needs of Landscape Plantings in California, A Landscape Coefficient Method and WUCOLS III*.

APPENDIX A

FIGURES



825 SONOMA AVENUE
SUITE C
SANTA ROSA, CA 95404
TEL: (707) 544-0784

LOCATION MAP

225 LOS ALAMOS ROAD
SANTA ROSA, CALIFORNIA

FIGURE
1

16–2352

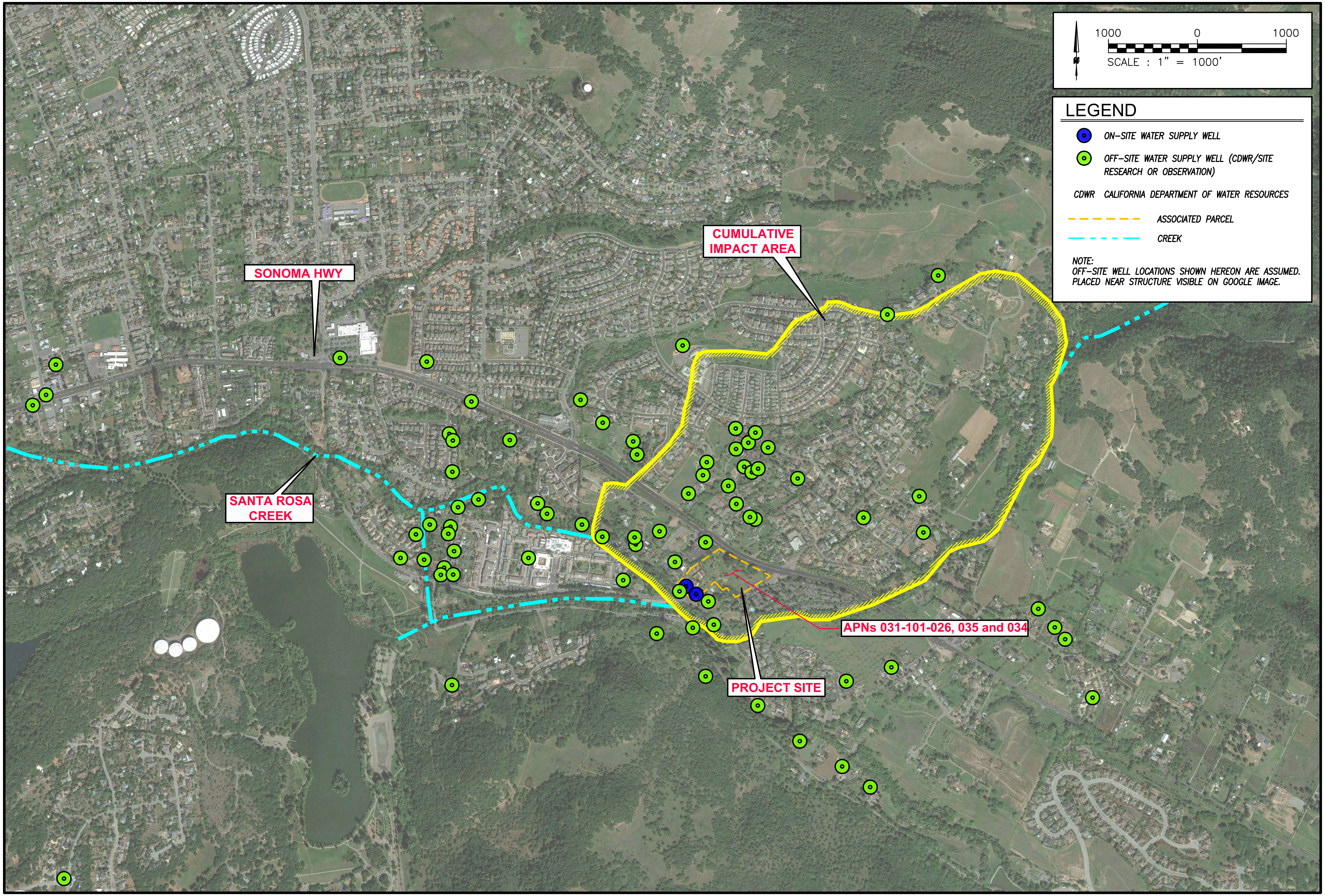


FIGURE 2

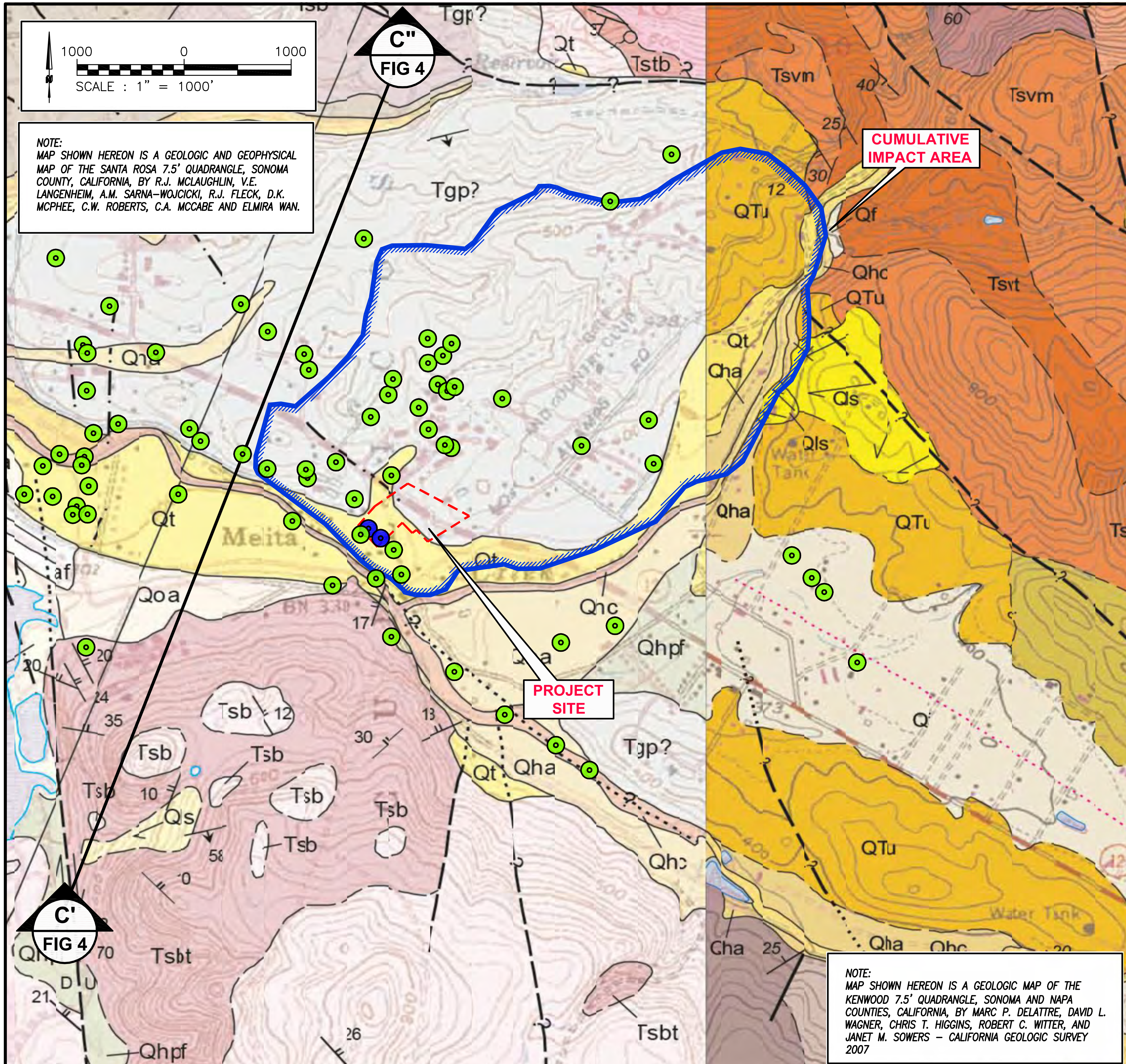
16-2352

SITE PLAN

225 LOS ALAMOS ROAD
SANTA ROSA, CALIFORNIA

EBA ENGINEERING
825 SONOMA AVENUE
SUITE C
SANTA ROSA, CA 95404
TEL: (707) 544-0784

Q:\2352\Cumulative Impact Area (Rev 5).dwg, 2/25/2020 7:46:38 AM



NOTE:
MAP SHOWN HEREON IS A GEOLOGIC AND GEOPHYSICAL MAP OF THE SANTA ROSA 7.5' QUADRANGLE, SONOMA COUNTY, CALIFORNIA, BY R.J. MCLAUGHLIN, V.E. LANGENHEIM, A.M. SARNA–WOJCICKI, R.J. FLECK, D.K. MCPHEE, C.W. ROBERTS, C.A. MCCABE AND ELMIRA WAN.

NOTE:
MAP SHOWN HEREON IS A GEOLOGIC MAP OF THE KENWOOD 7.5' QUADRANGLE, SONOMA AND NAPA COUNTIES, CALIFORNIA, BY MARC P. DELATTRE, DAVID L. WAGNER, CHRIS T. HIGGINS, ROBERT C. WITTER, AND JANET M. SOWERS – CALIFORNIA GEOLOGIC SURVEY 2007

LEGEND

- ON–SITE WATER SUPPLY WELL
- OFF–SITE WATER SUPPLY WELL (CDWR/SITE RESEARCH OR OBSERVATION)

SANTA ROSA QUADRANGLE

KENWOOD QUADRANGLE

- **Qf — Alluvial fan deposits (latest Pleistocene to Holocene)** – Moderately to poorly sorted deposits of sand, gravel, silt, and clay mapped on gently sloping, fan-shaped, relatively undissected alluvial surfaces.
- **Qha — Alluvium, undivided (Holocene)** – Alluvium deposited in fan, terrace or basin environments which could not be readily separated for mapping. Typically consists of poorly to moderately sorted sand, silt, and gravel that form smooth geomorphic surfaces with little to no dissection.
- **Qhc — Modern stream channel deposits (Holocene <150 years)** – Fluvial deposits within active, natural stream channels. Consists of loose alluvial sand, gravel, and silt.
- **Qls — Landslide deposits (Pleistocene to historic)** – Includes deep-seated rock slides, earth flows, and debris flow deposits. Arrows indicate direction of movement; queried where existence is questionable.
- **Qt — Stream terrace deposits (latest Pleistocene to Holocene)** – Moderately to well-sorted and bedded sand, gravel, silt, and minor clay mapped on relatively flat, undissected terraces where absolute age is uncertain.
- **QTu — Unnamed fluvial deposits (Pliocene to Pleistocene)** – Cobbly gravel interstratified with sand, silt, and minor clay. Previously mapped as Glen Ellen Formation (Weaver, 1949; Cardwell, 1958; Huffman and Armstrong, 1980) and/or Huichica Formation (Fox and others, 1973; Fox and others, 1985). Includes some reworked tuff and sparse obsidian pebbles, but less than typical for the type locality of the Glen Ellen Formation. Differentiated by the generally coarser composition and greater proportion of clasts derived from Franciscan basement rocks, including cobbles and occasional boulders of chert similar to that mapped along upper Santa Rosa Creek.
- **Tsvm — Mafic flows, undivided** – Andesite, basaltic andesite, and basalt in massive flows and breccias, with intercalated tuff. May be in part equivalent to Tsmb or Tsms.
- **Tsvt — Pumiceous ash-flow and minor air-fall tuff** – Locally welded or partly welded. Also includes some water-lain tuff and agglomerate. Tephra collected from a quarry northwest of Los Alamos Road correlates with the Lawlor Tuff with an age of 4.83 Ma (McLaughlin and others, in press). South of Annadel State Park, tephra from near top of unit north of Bennett Valley Road correlates with the tuff of Mark West Springs indicating ages between 4.83 and 5.02 Ma (McLaughlin and others, in press). In the same vicinity near Bennett Valley Road, K-Ar dating of tuff lower in the unit yielded an approximate age of 5.66 ± 0.33 Ma (Mankinen, 1972).

MAP SYMBOLS

- Contact between map units - Solid where accurately located, dashed where approximately located, queried where uncertain, dotted where concealed.
- Fault - Solid where accurately located, dashed where approximately located, dotted where concealed, queried where uncertain. Arrow and number indicate direction and angle of dip of fault plane.
- Thrust fault - barbs on upper plate; dashed where approximately located, dotted where concealed.
- Syncline - Dashed where approximately located, dotted where concealed.
- Anticline - Dashed where approximately located, dotted where concealed.
- Strike and dip of inclined bedding.
- Strike and dip of volcanic flow.
- Landslide - Arrows indicate principal direction of movement, queried where existence is questionable.

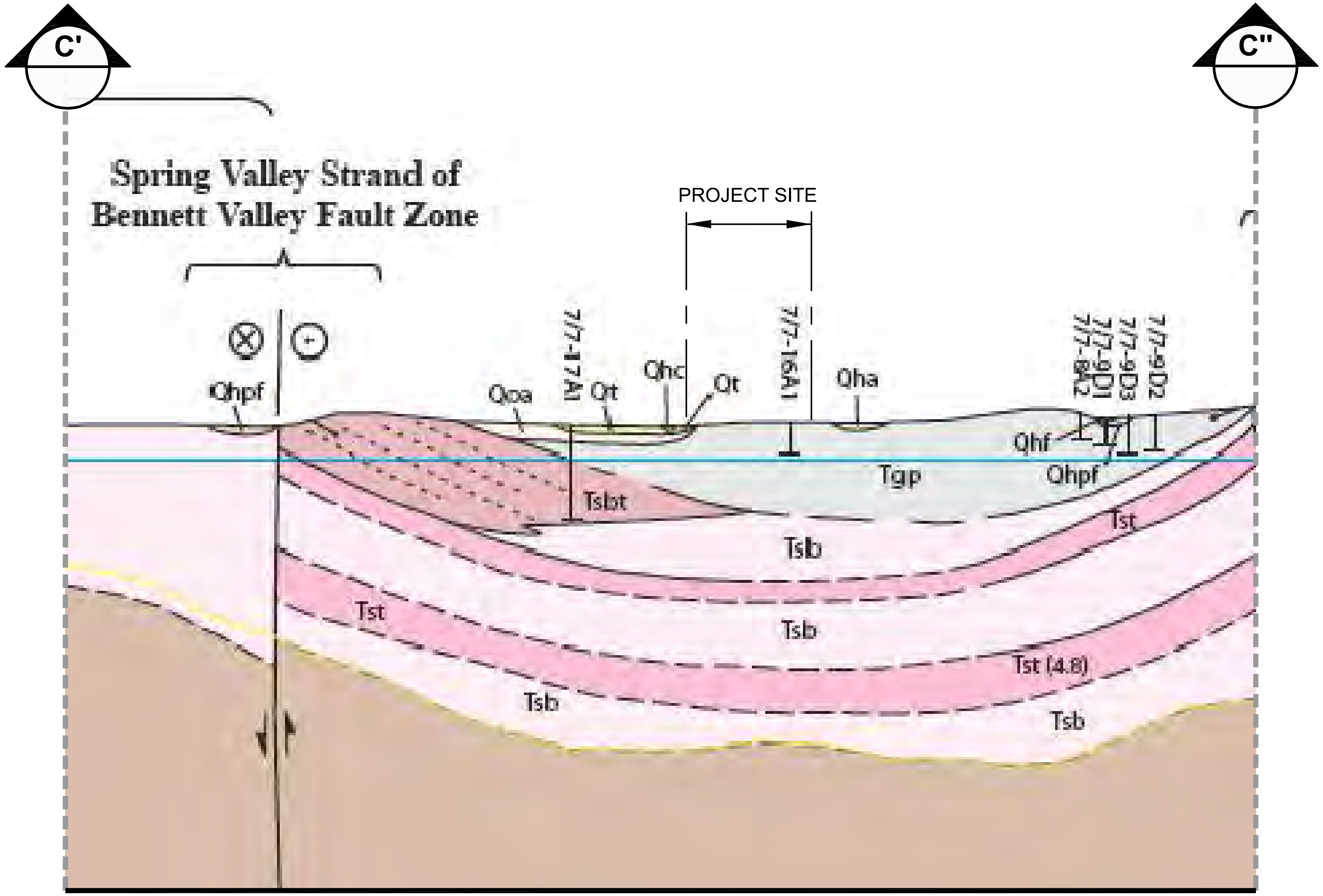
FIGURE 3

16–2352

GEOLOGIC MAP

225 LOS ALAMOS ROAD
SANTA ROSA, CALIFORNIA

EBA ENGINEERING
825 SONOMA AVENUE
SUITE C
SANTA ROSA, CA 95404
TEL: (707) 544-0784



SECTION C'-C"

AS DELINEATED IN PLAN VIEW
ON 'GEOLOGIC MAP' - FIGURE 3

SEE SANTA ROSA QUADRANGLE
LEGEND ON FIGURE 3 FOR
GEOLOGIC UNIT DESCRIPTIONS

APPROXIMATE SCALE:
HORIZONTAL: 1"=1000'
VERTICAL: NOT TO SCALE

NOTE:
CROSS SECTION SHOWN HEREON IS FROM A GEOLOGIC AND GEOPHYSICAL MAP OF THE SANTA ROSA 7.5' QUADRANGLE, SONOMA COUNTY, CALIFORNIA, BY R.J. MCLAUGHLIN, V.E. LANGENHEIM, A.M. SARNA-WOJCICKI, R.J. FLECK, D.K. MCPHEE, C.W. ROBERTS, C.A. MCCABE AND ELMIRA WAN.

FIGURE 4
16-2352

GEOLOGIC CROSS-SECTION

225 LOS ALAMOS ROAD
SANTA ROSA, CALIFORNIA

EBA ENGINEERING
825 SONOMA AVENUE
SUITE C
SANTA ROSA, CA 95404
TEL: (707) 544-0784

APPENDIX B

PETERSEN DRILLING AND PUMP TEST PUMP LOG

Test Pump Log

LES PETERSEN

Drilling & Pump Inc.

JOB: Episcopal Senior Communities **PUMP SIZE:** 1-HP SUBMERSIBLE PUMP

LOCATION: Los Alamos **SETTING:** 47'

WELL DEPTH: 52' **CASING SIZE:** 8" Steel **STATIC LEVEL:** 6'-1"

DATE STARTED: 10/26/2016 **DATE FINISHED:** 10/26/2016 **JOB #** Unknown

DATE:	TIME	Interval	TEST DATA					COMMENTS
			LEVEL	G.P.M.				
10/26/16	9:40 AM	1 Min	6'-1"	27.9				
10/26/16	9:41 AM	1 Min	8'-6"	27.2				
10/26/16	9:42 AM	1 Min	9'-2"	27.2				
10/26/16	9:43 AM	1 Min	9'-3"	27.2				
10/26/16	9:44 AM	1 Min	9'-4"	27.2				
				27.2				
10/26/16	9:45 AM	5 Min	9'-6"	27.2				
10/26/16	9:50 AM	5 Min	10'	27.2				
10/26/16	9:55 AM	5 Min	10'-3"	27.2				
10/26/16	10:00 AM	5 Min	10'-3"	27.2				Set throttle valve @
10/26/16	10:05 AM	5 Min	8'-8"	15				15-gpm per Jakes
10/26/16	10:10 AM	5 Min	8'-8"	15				instruction
10/26/16	10:15 AM	5 Min	8'-8"	15				
10/26/16	10:20 AM	5 Min	8'-8"	15				
10/26/16	10:25 AM	5 Min	8'-8"	15				
10/26/16	10:30 AM	5 Min	8'-8"	15				
10/26/16	10:35 AM	5 Min	8'-8"	15				
10/26/16	10:40 AM	5 Min	8'-8"	15				
10/26/16	10:45 AM	5 Min	8'-8"	15				
10/26/16	11:05 AM	20 Min	9'	15				
10/26/16	11:25 AM	20 Min	9'	15				
10/26/16	11:45 AM	20 Min	9'	15				
10/26/16	12:15 PM	30 Min	9'	15				
10/26/16	12:45 PM	30 Min	9'	15				
10/26/16	1:15 PM	30 Min	9'	15				
10/26/16	1:45 PM	30 Min	9'-1"	15				
10/26/16	2:15 PM	30 Min	9'-1"	15				
10/26/16	2:45 PM	30 Min	9'-1"	15				
10/26/16	3:15 PM	30 Min	9'-1"	15				
10/26/16	3:45 PM	30 Min	9'-1"	15				
10/26/16	4:15 PM	30 Min	9'-2"	15				
10/26/16	4:45 PM	30 Min	9'-3"	15				
10/26/16	5:15 PM	30 Min	9'-3"	15				
10/26/16	5:45 PM	30 Min	9'-3"	15				

Appendix F – Noise Assessment

ILLINGWORTH & RODKIN, INC.
Acoustics • Air Quality
429 East Cotati Avenue
Cotati, California 94931
Tel: 707-794-0400 *Fax: 707-794-0405*
www.illingworthrodkin.com *illro@illingworthrodkin.com*

March 6, 2020

Covia Communities
Attn: Mr. Frank Rockwood
2185 N. California Blvd., Ste. 575
Walnut Creek, CA 94596
VIA E-MAIL: frank@rockwoodpacific.com
CC: Michelle Gervais (Michelle@gervaisassociates.com)

SUBJECT: East Grove Expansion of Spring Lake Village
Acoustical Update for Partial or Maximum Cultural Avoidance Alternatives

Dear Mr. Rockwood;
Illingworth & Rodkin, Inc. (I&R) has conducted a qualitative review of the prior[1] and alternative[2] site development schemes to compare the relative impacts of the alternative schemes with the previous ones. These plans are attached for reference. Following we briefly present the results of this comparative review of the project Impacts and Mitigation Measures:

IMPACT A: NOISE AND LAND USE COMPATIBILITY.

Environmental noise on the proposed development:

No Change

I&R's 2017 report found the project site to be considered "Normally Acceptable" for residential use by the City Noise and Land Use Compatibility guidelines, such that exterior noise levels at outdoor use areas would meet City noise standards. The new Partial and/or Maximum Cultural Avoidance Alternatives would not place any project residential uses closer to Hwy 12, thus the impact determination from our 2017 report related to environmental noise exposure on the proposed development will remain the same.

Operational noise from the project:

No Change

The new Partial and/or Maximum Cultural Avoidance Alternatives would not place any project residential uses or the emergency generator closer to any adjacent (non-project) residential property lines. Because of this operational noise from the project on surrounding noise sensitive uses is expected to remain the same as that discussed in our 2017 report. Thus, the impact determination and recommended Mitigation Measures A1 and A2 from our 2017 report will remain the same for the new Partial or Maximum Cultural Avoidance Alternatives

---

[1] Identified as the 'Modified Original' and 'Main Street' Schemes in I&R's 2017 Environmental Noise Assessment report.
[2] Identified as the 'Partial Cultural Avoidance' and 'Maximum Cultural Avoidance' Alternatives.

IMPACT B: EXPOSURE TO GROUNDBORNE NOISE OR VIBRATION:

No Change

Because the new Partial and/or Maximum Cultural Avoidance Alternatives would not place any significant project elements (e.g. buildings, roads, etc.) closer to adjacent (non-project) residential uses, the potential for ground borne vibration generating project construction on non-project residential would be unchanged from our 2017 report. Thus, the impact determination and recommended Mitigation Measure B from our 2017 report will remain the same for the new Partial or Maximum Cultural Avoidance Alternatives.

IMPACT C: SUBSTANTIAL PERMANENT INCREASE IN AMBIENT NOISE LEVELS:

No Change

The new Partial and/or Maximum Cultural Avoidance Alternatives plan schemes would not be expected to generate significantly more or less noise from the occupation and use of the residential units or traffic on area roadways, thus this impact determination would be unchanged from those discussed in our 2017 report.

IMPACT D: SUBSTANTIAL TEMPORARY INCREASE IN AMBIENT NOISE LEVELS:

Possible change needed to protect existing on-site residences from Construction Noise.

Because the new Partial and/or Maximum Cultural Avoidance Alternatives would not place any significant project elements closer to adjacent (non-project) residential uses the potential for noise impact on these adjacent residential uses due to project construction would be unchanged from those discussed in our 2017 report. Thus, the impact determination and recommended Mitigation Measure D from our 2017 report will remain the same for the new Partial or Maximum Cultural Avoidance Alternatives for these adjacent (non-project) residential uses.

However, it is noted that the Maximum Cultural Avoidance Alternative would preserve existing single-family structures in the panhandle portion of the project site. Because these homes are on the project site, they may not need to be considered for possible construction noise impacts. However, if these homes are occupied during construction, occupants would be exposed to noise levels exceeding 65 dBA L_{eq} and 75 dBA L_{max} when nearby construction activities occur. Considering this the installation of temporary construction noise barriers with a height of 8 feet above grade as given in Mitigation Measure D a) in our 2017 report should be extended to include any occupied existing single-family structure in the panhandle portion of the project site under the Maximum Cultural Avoidance Alternative.

This concludes Illingworth & Rodkin's qualitative review of the prior and alternative site development schemes to compare the relative impacts of the alternative and previous site development plans. Please do not hesitate to call with any questions or concerns.

Sincerely,

Fred M. Svinth, INCE, Assoc., AIA
Senior Consultant, Principal
***Illingworth & Rodkin, Inc*.**

Attachments: Figure 1: Modified Original & Main Street Schemes from 2017 Report
Figure 2: 2020 Maximum & Partial Avoidance Alternatives

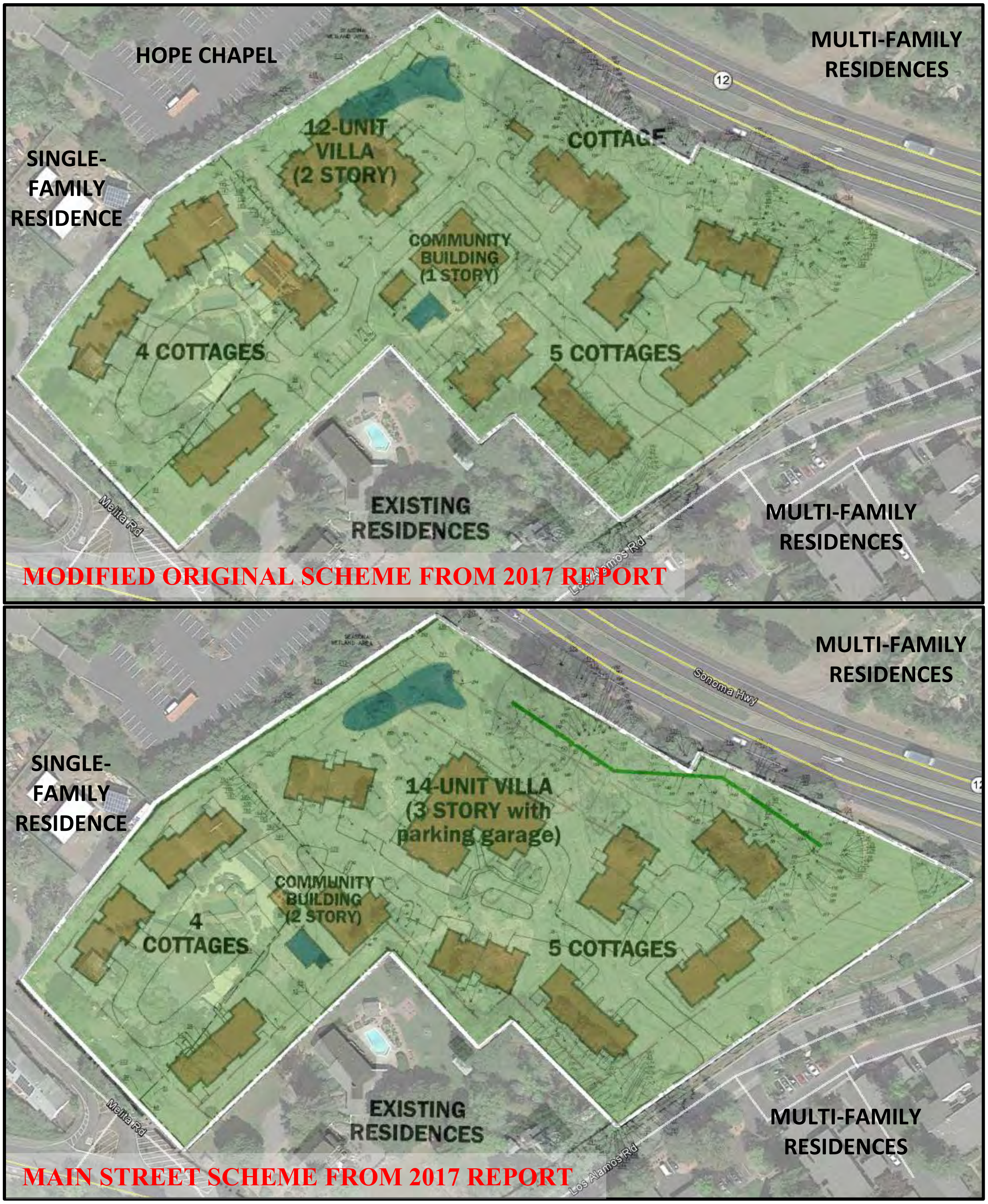


Figure 1: 2017 Site Plans

Figure 2: 2020 Alternative Site Plans

SPRING LAKE VILLAGE
EAST GROVE EXPANSION
ENVIRONMENTAL NOISE ASSESSMENT

Santa Rosa, California

July 25, 2017
Updated September 28, 2017

Prepared for:

Sharon York
Episcopal Senior Communities
2185 N. California Blvd., Suite 575
Walnut Creek, CA 94596

Prepared by:

Fred Svinth, INCE, Assoc. AIA

ILLINGWORTH & RODKIN, INC.
Acoustics • Air Quality
1 Willowbrook Court, Suite 120
Petaluma, CA 94954
(707) 794-0400

Job No.: 16-110

INTRODUC TION

This report provides an assessment of noise resulting from two versions of the proposed East Grove Expansion of Spring Lake Village (SLV), a residential continuing care retirement community within the city of Santa Rosa, California. This report includes a summary of applicable noise regulations, the results of a noise monitoring survey conducted for the project, and an assessment of noise impacts and mitigation measures necessary to meet the applicable City standards at adjacent noise sensitive land uses. Persons not familiar with environmental noise analysis are referred to Appendix A for additional discussion.

PROJE CT DES CRIPTION

The project involves the expansion of the existing campus onto an undeveloped site approximately 0.15 miles east of the main campus and improvements to nearby roadways. The two expansion plans studied in this report are identified as the "Modified Original" and "Main Street" plans. Both development schemes involve a total of 32 residential independent living units. The Modified Original plan would include twenty (20) residences in ten (10) single-story duplex cottages and twelve (12) residences in a single two-story residential villa, and the Main Street plan would include eighteen (18) residences in nine (9) single-story duplex cottages and twelve (12) residences in a single three-story residential villa. The expansion also includes a community center with an outdoor pool for residents as part of the Modified Original Project (the pool is not included in the Main Street Alternative) and various site structures for parking, resident garden, and maintenance. Off-site work will include improvements to the storm water system, and roadway pedestrian and bicycle improvements to facilitate walkability between the project site and the existing Spring Lake Village. Figure 1, below, shows the location of the project site in relation to surrounding land uses.

Figure 1: Site Location and Vicinity

REGULATORY BACKGROUND

The State of California and the City of Santa Rosa have established plans and policies that are designed to limit noise exposure at noise sensitive land uses. Plans and policies applicable to the proposed project include: (1) the State CEQA Guidelines, Appendix G; (2) Title 24, Part 2 of the State Building Code; (3) the City of Santa Rosa General Plan Noise Element; (4) the City of Santa Rosa Noise Ordinance; and (5) Caltrans Construction Vibration Criteria.

State CEQA Guidelines

The CEQA contains guidelines to evaluate the significance of effects of environmental noise attributable to a proposed project. Under CEQA, noise impacts would be considered significant if the project would result in:

(a) Exposure of persons to or generation of noise levels in excess of standards established in the local General Plan or Noise Ordinance, or applicable standards of other agencies;
(b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels;
(c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project;
(d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project;
(e) For a project located within an airport land use plan or where such a plan has not been adopted within two miles of a public airport or public use airport, if the project would expose people residing or working in the project area to excessive noise levels; or
(f) For a project within the vicinity of a private airstrip, if the project would expose people residing or working in the project area to excessive noise levels.

Checklist items (a), (b), (c), and (d) are relevant to the proposed project. The project is not located in the vicinity of a public or private airstrip; therefore, checklist items (e) and (f) are not carried forward in this analysis.

CEQA does not define what noise level increase would be considered substantial. Typically, project-generated noise level increases of 3 dBA L_{dn} or greater would be considered significant where exterior noise levels would exceed the normally acceptable noise level standard (60 dBA L_{dn} for residential land uses). Where noise levels would remain at or below the normally acceptable noise level standard with the project, noise level increases of 5 dBA L_{dn} or greater would be considered significant.

In December 2015, the California Supreme Court determined that an analysis of the impacts of the environment on a project – known as "CEQA-in-reverse" – is only required under two limited circumstances: (1) when a statute provides an express legislative directive to consider such impacts; and (2) when a proposed project risks exacerbating environmental hazards or conditions that already exist (Cal. Supreme Court Case No. S213478). The Supreme Court reversed the Court of Appeal's decision and remanded the matter back to the appellate court to reconsider the case in light of the Supreme Court's ruling. Accordingly, the case is currently pending back in the Court of Appeal. Because the Supreme Court's holding concerns the effects of the environment on a project (as contrasted to the effects of a proposed project on the environment), and not the science behind the thresholds, the four (4) CEQA checklist items (items a, b, e, and f) regarding non-project generated noise exposure increases (e.g., exposure of the project residents to exterior or interior noise levels, as well as groundborne vibration and aircraft noise), are not required analysis under CEQA since these items involve the surrounding environment's impact on the project residents. Such analysis contained herein of Impacts A and B and any suggested measures to address noise or vibration exposure on project residents are included in this report for compliance with the City of Santa Rosa General Plan and/or Municipal Code requirements and Title 24, Part 2 of the California Building Code as opposed to CEQA.

2013 California Building Code, Title 24, Part 2

The current (2013) California Building Code (CBC) does not place limits on interior noise levels attributable to exterior environmental noise sources. The July 1, 2015 Supplement to the 2013 California Building Code (CBC) corrects this omission, reinstating limits on interior noise levels attributable to exterior environmental noise sources which had been contained in all prior versions of the CBC dating back to 1974. In keeping with the provisions of the 2015 supplement, this report considers interior noise levels attributable to exterior environmental noise sources to be limited to a level not exceeding 45 dBA L_{dn} in any habitable room for new dwellings other than detached single-family dwellings.

City of Santa Rosa General Plan

The Noise and Safety Element of the City of Santa Rosa's General Plan identifies policies that are intended to guide the development of new projects with regard to exposure to or generation of noise. The policies support the City's goal of maintaining an acceptable community noise level. The following policies are applicable to the proposed project:

NS-B Maintain an acceptable community noise level to protect the health and comfort of people living, working and/or visiting in Santa Rosa, while maintaining a visually appealing community.

- Multi-family residential uses are considered to be normally acceptable in areas with a noise environment of L_{dn} of less than 65 dBA and conditionally acceptable in areas exposed to an L_{dn} of 60 to 70 dBA.

NS-B-1 Do not locate noise-sensitive uses in proximity to major noise sources, except residential is allowed near rail to promote future ridership.

NS-B-2 Encourage residential developers to provide buffers other than sound walls, where practical. Allow sound walls only when projected noise levels at a site exceed land use compatibility standards in Figure 12-1.

NS-B-3 Prevent new stationary and transportation noise sources from creating a nuisance in existing developed areas. Use a comprehensive program of noise prevention through planning and mitigation, and consider noise impacts as a crucial factor in project approval.

NS-B-4 Require new projects in the following categories to submit an acoustical study, prepared by a qualified acoustical consultant:

- All new projects that could generate noise whose impacts on other existing uses would be greater than those normally acceptable.
- All new projects proposed for areas with existing noise above 60 dBA L_{dn}. Mitigation shall be sufficient to reduce noise levels below 45 dBA L_{dn} in habitable rooms and 60 dBA L_{dn} in private and shared recreational facilities. Additions to existing housing units are exempt.

NS-B-5 Pursue measures to reduce noise impacts primarily through site planning. Engineering solutions for noise mitigation, such as sound walls, are the least desirable alternatives.

NS-B-6 Do not permit existing uses to generate new noises exceeding normally acceptable levels unless those noises are mitigated to acceptable levels.

NS-B-9 Encourage developers to incorporate acoustical site planning into their projects. Recommended measures include:

- Incorporating buffers and/or landscaped earth berms;
- Orienting windows and outdoor living areas away from unacceptable noise exposure;
- Using reduced-noise pavement (rubberized-asphalt);
- Incorporating traffic calming measures, alternative intersection designs, and lower speed limits; and
- Incorporating state-of-the-art structural sound attenuation and setbacks.

NS-B-10 Work with private enterprises to reduce or eliminate nuisance noise from industrial and commercial sources that impact nearby residential areas. If progress is not made within a reasonable time, the City shall issue abatement orders or take other legal measures.

NS-B-14 Discourage new projects that have potential to create ambient noise levels more than 5 dBA L_{dn} above existing background, within 250 feet of sensitive receptors.

City of Santa Rosa Noise Ordinance

The City of Santa Rosa has adopted a quantitative noise ordinance in Chapter 17-16 of the Municipal Code. Section 17-16.120 regulates noise from machinery and equipment: "It is unlawful for any person to operate any machinery, equipment, pump, fan, air conditioning apparatus, or similar mechanical device in any manner so as to create any noise which would cause the noise level at the property line of any property to exceed the ambient base noise level by more than 5 decibels. Ambient base noise levels for residential areas are established in Section 17-16.030. The applicable ambient noise level criteria are shown in Table 1, below;

TABLE 1: City of Santa Rosa Municipal Code Ambient Base Noise Levels (dBA)

Land Use Zone	Daytime Level	Evening Level	Nighttime Level
Single-Family Residential	55	50	45
Multi-Family Residential	55	55	50
Office and Commercial	60	60	55
Intensive Commercial	65	65	55
Industrial	70	70	70

Source: City of Santa Rosa, City of Santa Rosa Municipal Code 17-16.030, 1989

The Noise Ordinance defines ambient noise as follows:

"Ambient noise is the all-encompassing noise associated with a given environment usually a composite of sounds from many sources near and far. For the purpose of this chapter, ambient noise level is the level obtained when the noise level is averaged over a period of 15 minutes without inclusion of noise from isolated identifiable sources at the location and time of day near that at which a comparison is to be made."

The noise descriptor, L_{eq}, is used in this report for the purposes of determining noise with respect to these limits.

California Department of Transportation - Construction Vibration.
Caltrans recommends a vibration limit of 0.5 in/sec PPV for buildings structurally sound and designed to modern engineering standards. A conservative vibration limit of 0.25 to 0.30 in/sec PPV has been used for older buildings that are found to be structurally sound but cosmetic damage to plaster ceilings or walls is a major concern. For historic buildings or buildings that are documented to be structurally weakened, a conservative limit of 0.08 in/sec PPV is often used to provide the highest level of protection. All of these limits have been used successfully and compliance to these limits has not been known to result in appreciable structural damage. All vibration limits referred to herein apply on the ground level and take into account the response of structural elements (i.e. walls and floors) to ground-borne excitation.

EXISTING NOISE ENVIRONMENT

The project site is bordered by existing single-family residential uses to the northwest and southeast at the site entry near Melita Road, multi-family residential uses to the southeast opposite Los Alamos Road, the Hope Chapel to the northwest, and distant single family homes opposite Hwy 12 to the northeast. The noise environment at the project site and the general vicinity is dominated by traffic on Hwy 12, Los Alamos Road, with distant traffic from Melita Road and Montgomery Drive. To evaluate the existing noise environment on the project site three (4) long term noise and three short term measurements were conducted. Two long term measurements (LT-1 and LT-2) were conducted simultaneously over a 117-hour weekend/holiday/weekday period between 2:00 p.m. on Friday, May 27th and 11:00 a.m. on Wednesday, June 1st, 2016, the third long term measurement (LT-3) was conducted over a 50-hour weekday period between 12:00 p.m. on Wednesday, June 1st and 2:00 p.m. on Friday, June 3rd, 2016 and the fourth long term measurement (LT-3) was conducted over a 98-hour weekend/weekday period between 2:00 p.m. on Friday, July 14th and 4:00 p.m. on Tuesday, July 18th, 2017. The three short term measurements (ST-1, 2, & 3) were conducted simultaneously with the monitor at position LT-4 at the other three long term positions (LT-1, 2, & 3) between 2:50 p.m. and 3:40 p.m. on July 18th, 2017 to update the previous (2016) measurement results for current conditions. The approximate location of all measurements relative to the both site development schemes and surrounding vicinity are shown in Figure 2.

All noise measurements were made with Larson Davis Model 820 Integrating Sound Level Meters set at “slow” response. The sound level meters were equipped with a G.R.A.S. Type 40AQ ½ - inch random incidence microphones fitted with windscreens. All instrumentation used meets the requirements of the American National Standards Institute (ANSI) SI.4-1983 for Type 1 use. The sound level meters were calibrated prior to the noise measurements using a Larson Davis Model CAL200 acoustical calibrator. During the measurement period the weather was clear with no precipitation.

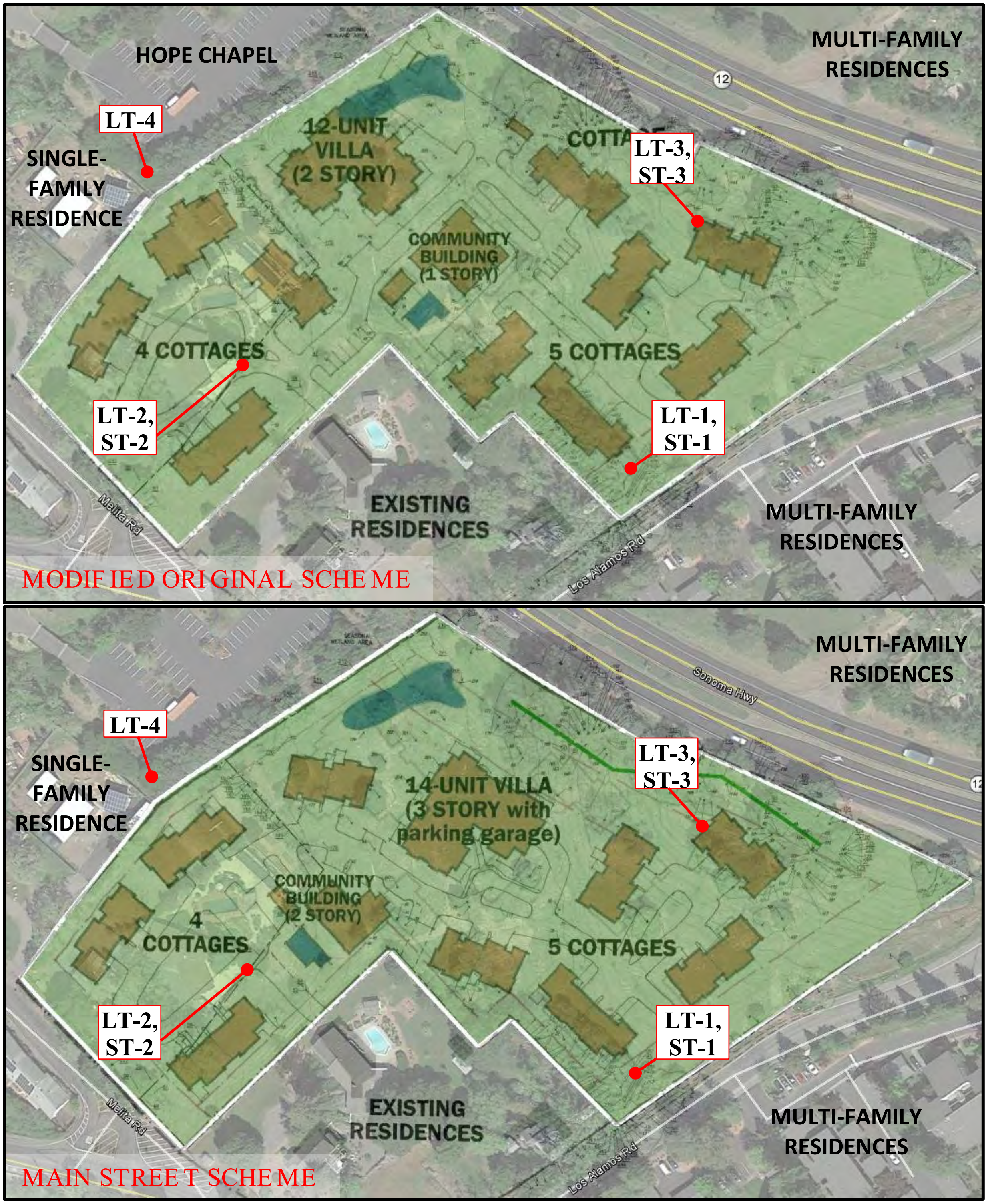
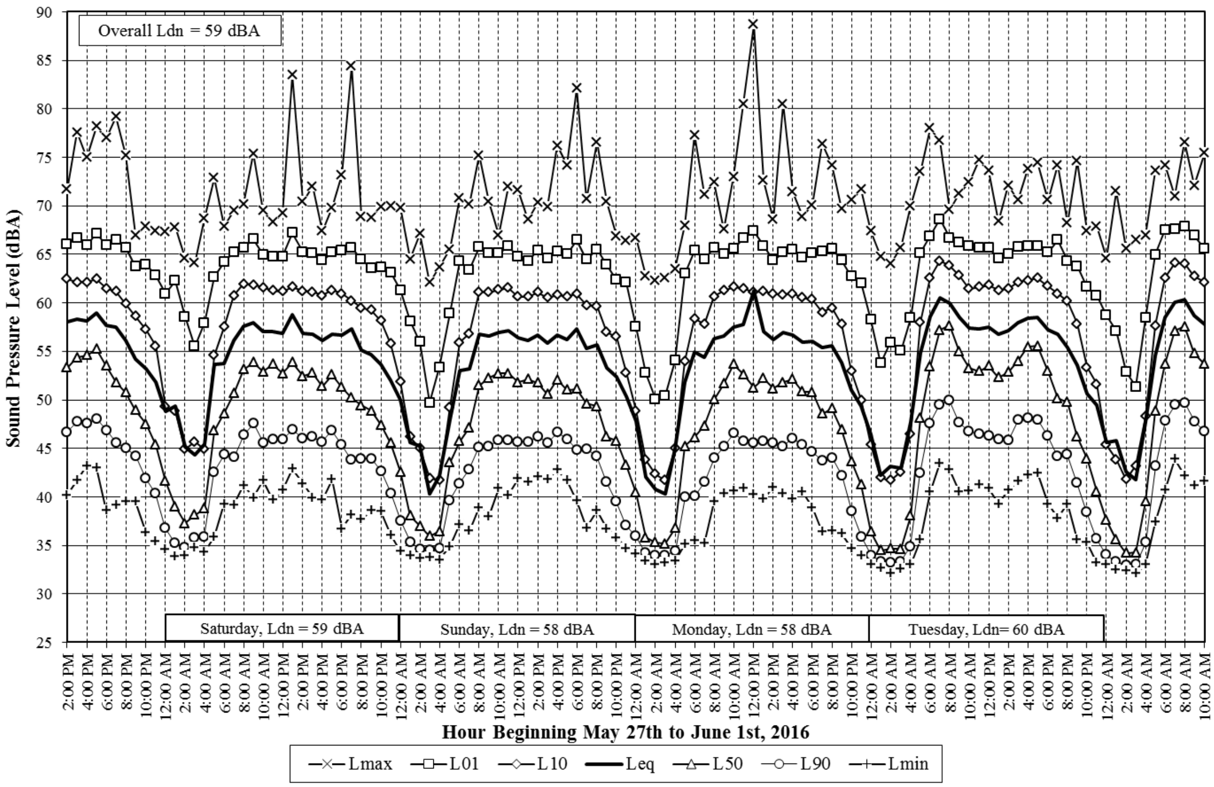


Figure 2: Site Plans, Measurement Locations, and Adjacent Uses

The first long-term sound level measurement (LT-1) was conducted over a 117-hour weekend/memorial day holiday/weekday period between 2:00 p.m. on Friday, May 27th and 11:00 a.m. on Wednesday, June 1st, 2016 in a wooded area on the Los Alamos Road project frontage on a tree trunk at a distance of approximately 72 feet from the roadway centerline which is the approximate distance of the adjacent single family home and the closest residential façades of the Los Alamos townhomes to the roadway centerline. This measurement also represents the existing noise environment approximately 12 feet closer to the roadway centerline than the closest facades of the project buildings to Los Alamos Road. Noise levels measured at this site were primarily produced by traffic on Los Alamos Road, with sounds from the adjacent single family residence, wind in trees, and bird chirps, insects, and other noise associated with wooded areas also contributing to the noise environment. The hourly trend in noise levels at this location, including the energy equivalent noise level (L_{eq}), maximum (L_{max}), minimum (L_{min}), and the noise levels exceeded 1, 10, 50, and 90 percent of the time (indicated as L_{01}, L_{10}, L_{50}, and L_{90}) are shown on Chart 1.

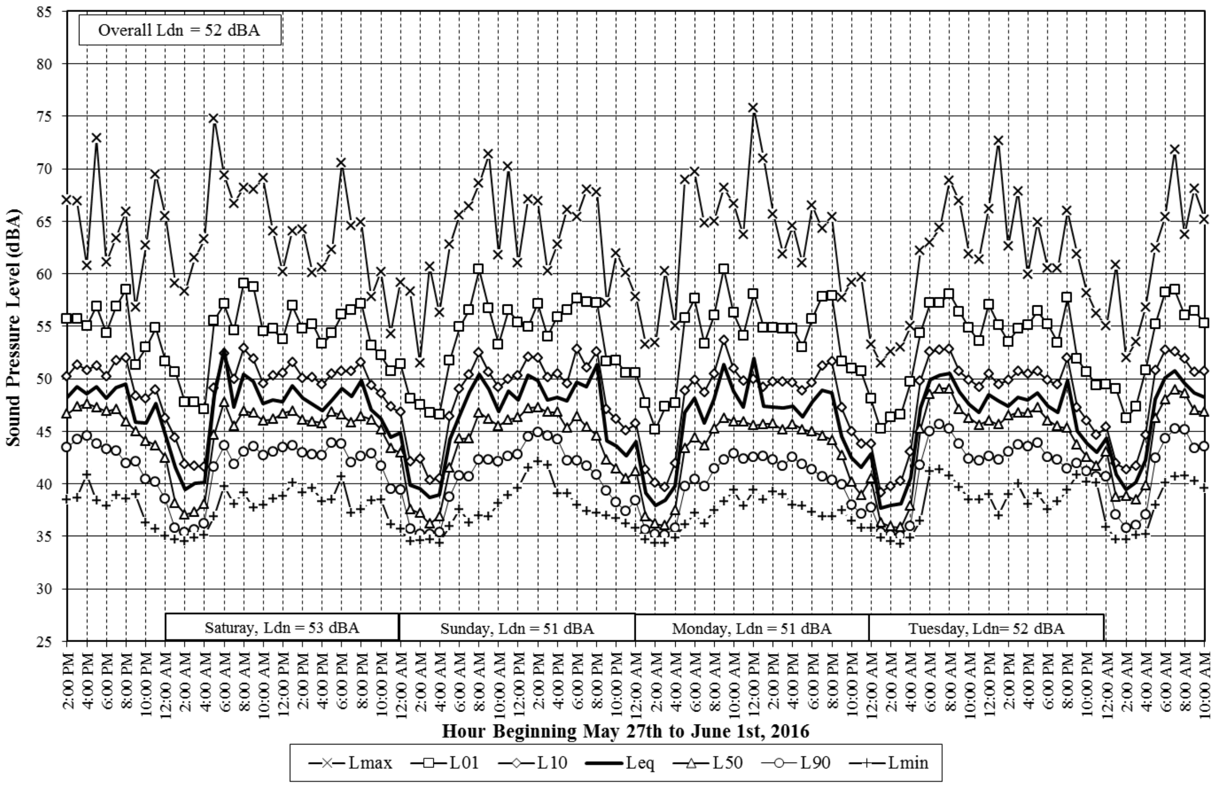
Chart 1: Measured Noise Levels at LT-1



The average weekday noise levels at this location ranged from 53 to 60 dBA L_{eq} during the day, and 42 to 59 dBA L_{eq} at night, the average weekend noise levels ranged from 53 to 59 dBA L_{eq} during the day and 40 to 54 dBA L_{eq} at night, and the average noise levels on the Memorial Day holiday ranged from 54 to 61 dBA L_{eq} during the day, and 40 to 55 dBA L_{eq} at night. The calculated average day/night noise level (L_{dn}) at this location ranged from 58 and 59 dBA, with an overall L_{dn} of 59 dBA.

The second long-term sound level measurement (LT-2) was conducted on the upper trunk of a tree approximately 230 feet from the centerline of Melita Road in the vicinity of the central outdoor use area between the cottages closest to Melita road. This measurement was also made over a 117-hour weekend/memorial day holiday/weekday period between 2:00 p.m. on Friday, May 27th and 11:00 a.m. on Wednesday, June 1st, 2016. Noise levels measured at this site were primarily produced by traffic on Montgomery and Melita Roads, with sounds from the adjacent single family residence, wind in trees, bird chirps, and insects also contributing to the noise environment. The hourly trend in noise levels at this location, including the energy equivalent noise level (L_{eq}), maximum (L_{max}), minimum (L_{min}), and the noise levels exceeded 1, 10, 50, and 90 percent of the time (indicated as L_{01}, L_{10}, L_{50}, and L_{90}) are shown on Chart 2, following.

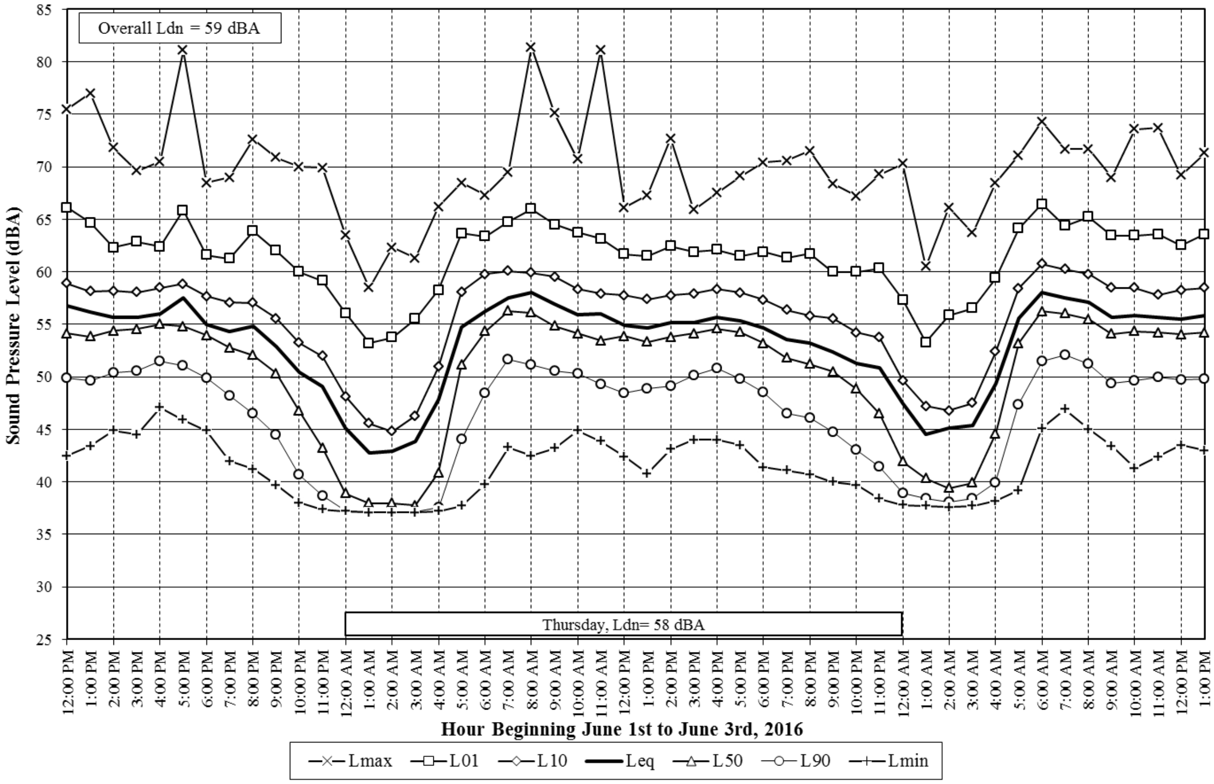
Chart 2: Measured Noise Levels at LT-2



The average weekday noise levels at this location ranged from 45 to 51 dBA L_{eq} during the day, and 38 to 50 dBA L_{eq} at night, the average weekend noise levels ranged from 44 to 51 dBA L_{eq} during the day and 39 to 43 dBA L_{eq} at night, and the average noise levels on the Memorial Day holiday ranged from 45 to 52 dBA L_{eq} during the day, and 38 to 48 dBA L_{eq} at night. The calculated average day/night noise level (L_{dn}) at this location ranged from 51 and 52 dBA, with an overall L_{dn} of 52 dBA.

The third measurement (LT-3) was conducted over a 50-hour weekday period between 12:00 p.m. on Wednesday, June 1st and 2:00 p.m. on Friday, June 3rd, 2016 on a tree trunk near the future façade of the proposed residence nearest Highway 12 (Cottage 2 as shown in Figure 2. Noise levels measured at this site were primarily produced by traffic on Hwy 12, with noise associated with wind in trees, woodland noise and distant residential and commercial noise also contributing to the noise environment. The hourly trend in noise levels at this location, including the energy equivalent noise level (L_{eq}), maximum (L_{max}), minimum (L_{min}), and the noise levels exceeded 1, 10, 50, and 90 percent of the time (indicated as L_{01}, L_{10}, L_{50}, and L_{90}) are shown on Chart 3, following.

Chart 3: Measured Noise Levels at LT-3

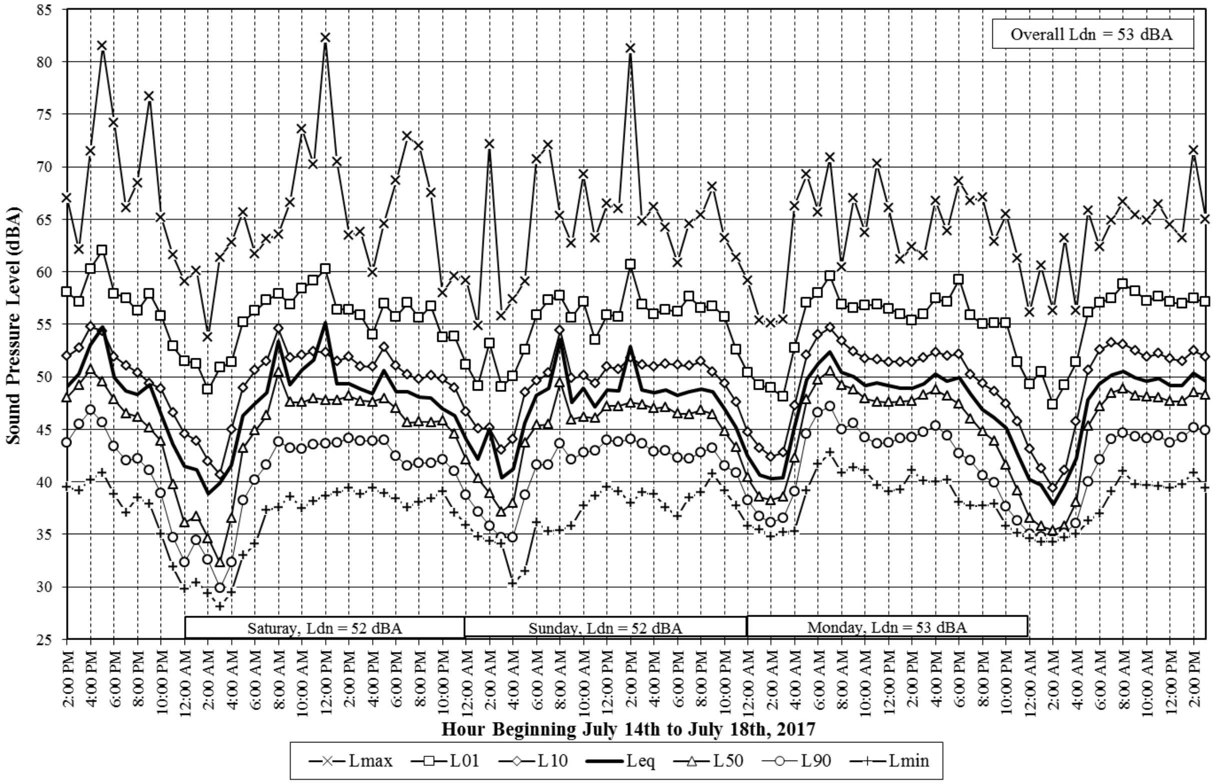


The average weekday noise levels at this location ranged from 50 to 58 dBA L_{eq} during the day and 43 to 58 dBA L_{eq} at night. The calculated average day/night noise level (L_{dn}) at this location ranged from 58 and 59 dBA, with an overall L_{dn} of 59 dBA.

The fourth measurement (LT-4) was conducted over a 98-hour weekend/weekday period between 2:00 p.m. on Friday, July 14th and 4:00 p.m. on Tuesday, July 18th, 2017 on a tree trunk near the property line shared by the proposed development, the Hope Chapel and the residential property north of the project site as shown in Figure 2. Noise levels measured at this site were primarily produced by traffic on Hwy 12, with noise associated with wind in trees, woodland noise and weekend parking lot noise and activities associated with the Hope Chapel. The hourly trend in noise levels at this location, including the energy equivalent noise level (L_{eq}), maximum (L_{max}), minimum (L_{min}), and the noise levels exceeded 1, 10, 50, and 90 percent of the time (indicated as L_{01}, L_{10}, L_{50}, and L_{90}) are shown on Chart 4, following.

The average weekday noise levels at this location ranged from 46 to 55 dBA L_{eq} during the day, and 35 to 51 dBA L_{eq} at night, the average weekend noise levels ranged from 47 to 55 dBA L_{eq} during the day and 39 to 48 dBA L_{eq} at night. The calculated average day/night noise level (L_{dn}) at this location ranged from 52 and 53 dBA, with an overall L_{dn} of 53 dBA.

Chart 4: Measured Noise Levels at LT-4



SHORT TERM NOISE MEASUREMENTS
The results of the three short term measurements (ST-1, 2, & 3) and the simultaneously measured levels at position LT-4 on July 18th, 2017 are shown in Table 2.

Table 2: Short term Noise Measurement Results

Measurement Location	Time Beginning	Sound Levels (dBA)							Current calculated (2017) L_{dn} at ST position	Original measured (2016) L_{dn} at ST position
		L_{max}	L_{01}	L_{10}	L_{eq}	L_{50}	L_{90}	L_{min}		
ST-1*(LT-1)*	**2:50 pm**	**72**	**69**	**61**	**58**	**53**	**48**	**43**	**60**	**59**
LT-4	*2:50 pm*	*67*	*61*	*53*	*51*	*49*	*46*	*43*		
ST-2*(LT-2)*	**3:10 pm**	**58**	**56**	**51**	**48**	**47**	**45**	**43**	**51**	**52**
LT-4	*3:10 pm*	*60*	*57*	*52*	*50*	*48*	*45*	*43*		
ST-3*(LT-3)*	**3:30 pm**	**62**	**61**	**58**	**55**	**55**	**50**	**43**	**58**	**59**
LT-4	*3:30 pm*	*57*	*55*	*52*	*49*	*49*	*44*	*39*		

Based on the results of the short term measurements conducted at the 2016 long term monitoring positions the L_{dn} levels on the site appear to have changed by +1 dBA. As discussed on page 1 of Appendix A, Sound level meters can accurately measure environmental noise levels to within about plus or minus 1 dBA, therefore we would judge the on-site noise environment during the 2017 measurement survey to be acoustically equivalent to that evaluated in the 2016 measurement survey.

NOISE ENVIRONMENT WITH THE PROJECT

A review of the traffic volumes shown in Figure 1 of the project traffic study (dated 9-19-17) indicates that the noise environment on the project site and surroundings properties adjacent to Hwy 12 and Los Alamos Road would increase by 1 dBA or less under future conditions without project implementation. The review of these traffic volumes also shows that project related traffic would result in no increase the noise environment on the project site and surroundings properties adjacent to Hwy 12 and in a 0.1 dBA increase the noise environment on the project site and surroundings properties adjacent to Los Alamos Road. Considering these findings, the noise environment on the project site and surrounding uses under project conditions would be approximately 1 decibel higher than existing noise levels. This increase would result in an L_{dn} level of 60 dBA at the building facades closest to Hwy 12 and Los Alamos Roads.

NOISE IMPACTS AND MITIGATION MEASURES

SIGNIFICANCE CRITERIA

Paraphrasing from Appendix G of the CEQA Guidelines, a project would normally result in significant noise impacts if noise levels generated by the project conflict with adopted environmental standards or plans, if the project would expose people to or generate excessive ground borne vibration levels, or if ambient noise levels at sensitive receivers would be substantially increased over a permanent, temporary, or periodic basis.

The following criteria were used to evaluate the significance of environmental noise and vibration resulting from the project (corresponding to the CEQA checklist items):

A. **Noise and Land Use Compatibility:** A significant noise impact would result if the project would expose persons to or generate noise levels that would exceed applicable noise standards presented in the City of Santa Rosa General Plan or Noise Ordinance.

B. **Groundborne Vibration:** A significant impact would be identified if the construction of the project would expose persons to excessive vibration levels. Groundborne vibration levels exceeding 0.25 in/sec PPV would have the potential to result in "architectural" damage to normal buildings.

C. **Substantial Permanent Increase in Ambient Noise Levels:** A significant impact would be identified if traffic or operational noise generated by the project would substantially increase noise levels at sensitive receivers in the vicinity. A substantial increase would occur if: a) the noise level increase is 5 dBA L_{dn} or greater, with a project condition noise level of less than 60 dBA L_{dn}, or b) the noise level increase is 3 dBA L_{dn} or greater, with a project condition noise level of 60 dBA L_{dn} or greater.

D. **Substantial Temporary Increase in Ambient Noise Levels:** A significant noise impact would be identified if construction related noise would result in a substantial temporary increase in ambient noise levels. Construction noise is typically considered significant when noise from construction activities exceed 60 dBA L_{eq} and the ambient noise environment by at least 5 dBA L_{eq} for a period of greater than one year or more at exterior areas of noise sensitive residential uses in the project area, or if noise levels produced by construction activities would result in interior noise levels within adjacent residences which could result in significant speech interference. As discussed in Appendix A, the threshold for speech interference indoors is about 45 dBA if the noise is steady and above 55 dBA if the noise is fluctuating. Thus, constant noise from construction related activities would begin to result in speech interference at a level of 45 dBA, while maximum noise from construction related activities would result in speech interference at a level of 55 dBA or above. Also per Appendix A, typical structural attenuation is as low as 12 dBA with open windows, around

20 dBA for an older structure with closed windows in good condition and around 25 dBA for a newer dwelling. Considering that the existing residences are not new, but generally in good condition, a consideration that neighbors would generally choose to close their windows for other reasons in addition to noise control during periods of heavy, close construction, and that most construction noise levels are fluctuating in nature, residential speech interference is considered possible when noise levels at the exterior facades of residences in the project vicinity reach average (L_{eq}) levels of 65 dBA or maximum (L_{max}) noise levels of 75 dBA.

As discussed in the Regulatory Section under CEQA, based on the CBIA vs. BAAQMD decision impacts a and b are included in this report for compliance with the City of Santa Rosa General Plan and/or Municipal Code requirements and Title 24, Part 2 of the California Building Code as opposed to CEQA.

Impact A: **Noise and Land Use Compatibility.** Though residential land uses proposed on the project site would be exposed to exterior noise levels 60 dBA L_{dn} or less, adjacent noise sensitive uses would be exposed to average exterior noise levels greater than City Noise Ordinance limits due the operation of on-site project machinery and equipment. **This is a less than significant impact with the incorporation of mitigation.**

The project proposes the construction of multi-family residential units on a site west of the Hwy 12 and Los Alamos Road intersection, as shown in Figure 2. A review of the project plans (see Figure 2) indicates that the residences proposed on the site will generally have small outdoor patios. These areas are expected to be exposed to an L_{dn} of 60 dBA or less under project conditions. In both the Modified Original and Main Street Schemes, common outdoor use areas will be provided in central site areas near the Community Building well removed from Hwy 12 and other roadways and will be shielded from these noise sources by intervening building structures. Therefore these areas are expected to be exposed to noise levels characterized by an L_{dn} of 55 dBA or less under project conditions. Based on this the project site would be considered "Normally Acceptable" for residential use by the City Noise and Land Use Compatibility guidelines, such that exterior noise levels at outdoor use areas would meet City noise standards. Additionally, considering typical residential structural attenuation factors (see Appendix A, page 2), interior noise levels would be expected to be below 45 dBA L_{dn} without the incorporation of noise insulation features into the project's design. **This is a less than significant impact.**

Either proposed project scheme is expected to include heating, ventilation and cooling (HVAC) equipment for the proposed residential and community buildings. The Community Building under either scheme is expected to have at least one large outdoor condensing unit located at ground level with louvers, flues and intake vents on the side of the building, and a remote condensing unit rack and exhaust fans in the roof well. The Villa building under either scheme is expected to have a large exterior air handler, platform mounted condensing units and exhaust fans in the roof well, and wall exhausts vents for units and dryers. Each of the Cottages under either scheme will have a condensing unit on ground level along with wall mounted exhaust vents for units, garages and dryers.

Based on noise measurements made at comparable facilities, the exhaust fans, large air handler and larger outdoor condensing units at the Villa and Community building may produce constant noise levels of between 58 to 63 dBA L_{eq} at 50 feet, and the outdoor condensing units at the Cottages may produce constant sound levels of 47 to 50 dBA L_{eq} at 50 feet. Wall exhausts vents at the buildings are expected to produce noise levels of less than 40 dBA at 50 feet. All of these types of equipment may run continuously during both daytime and nighttime hours.

A review of the current site plan shows that the residential cottages will be as close as 23 feet from the nearest residential property line under either scheme, the Villa building will be as close as 30 feet from the nearest residential property line under the Modified Original Scheme, and the Community Building will be as close as 30 feet from the nearest residential property line under the Main Street Scheme. Additionally, under the Modified Original and Main Street Schemes the residential cottages will be as close as 110 feet from the property line of the Villa Los Alamos multi-family residences (across Los Alamos Road).

Given these distances, the expected sound levels for building HVAC equipment discussed above, a consideration that equipment mounted in roof wells typically receive 10 dB or more of attenuation at ground level receivers from the parapet walls, noise levels from mechanical equipment at the Villa and Community buildings would be below 50 dBA at the adjacent property lines. Noise levels due to the operation of the ground level outdoor condensing units at the cottages would be expected to be between 54 and 57 dBA at the closest on site residential property line and sound levels below 45 dBA at the property line of the Villa Los Alamos multi-family residences (across Los Alamos Road). The levels across Los Alamos Road, would therefore meet the City's Noise Ordinance limits, and the levels at the on-site property line would meet the City's daytime Noise Ordinance limits, but would exceed the City's nighttime Noise Ordinance limit of 50 dBA. **This is a potentially significant noise impact.**

The facility will also be equipped with an emergency generator. While the generator has not yet been specified, based on experience with such equipment and given the size of the proposed facility, if the generator is a non-enclosed, open air unit it may produce sound levels of up to 96 dBA at 23 feet. However, if the generator is specified with an attenuating enclosure operational sound levels the operation levels are expected to drop to 75 to 83 dBA at 23 feet.

The original site plan showed that the emergency generator will be as close as 225 feet from the nearest residential property line. Under the Modified Original Scheme the generator appears to be placed in the same location, however in the Main Street Scheme the site plan shows the generator in a building on the northeast side of the Villa at a distance of approximately 250 feet from the nearest residential property line. At a distances of 225 and 250 feet, noise from the operation of an emergency generator would produce sound levels of between 54 to 63 dBA with a sound attenuating enclosure, and up to 77 dBA if a non-enclosed, open air unit is installed. Based on this, the specification of an emergency generator without a sound attenuating enclosure may result in noise levels which exceed the daytime Noise Ordinance limit at the nearest residential property line. **This is a potentially significant noise impact.**

Mitigation Measure A1: To allow evening and nighttime operation of the Cottage outdoor condensing units to meet the City Noise Ordinance limit of 50 dBA or less in rear yards of the adjacent single-family residences;

a. The condensing units of Cottages adjacent to residential property lines should be located at the front of the buildings (out of line of sight to the residential property line), or

b. A noise barrier fence/wall with a minimum top of wall elevation of 6 feet above the finish grade of the adjacent cottages level should be constructed on the property line adjacent residential property line.

To be effective as a barrier to noise, the noise barrier fence/wall should be built without cracks or gaps in the face or large or continuous gaps at the base or where they adjoin the homes or each other. The wall should also have a minimum surface weight of 3.0 lbs. per sq. ft. Acceptable materials for such walls include a 2x4 wood framed wall with wood or stucco finishes, masonry, and pre-cast concrete panels. A wood fence type wall may also be used. For a wood fence to meet these requirements, we typically recommend that the fence be double faced with butted vertical fence boards on each side with a continuous layer of 1/2" plywood. Using the plywood ensures continued effectiveness of the barrier with age, since wood slats alone have a tendency to warp and separate with age allowing gaps to form and the barrier effect of the wall to diminish.

Mitigation Measure A2: The emergency generator should not be located closer than 225 feet from adjacent property lines, and shall be fitted with an acoustical enclosure that is specified to produce noise emissions of no more than 75 dBA at a distance of 23 feet from any side of the enclosure. Additionally emergency generator testing should only be conducted between the hours of 7 am and 7pm.

Significance after Mitigation
The implementation of Mitigation Measures A1 and A2 will allow the operation of the residential and community buildings HVAC systems and the facility's emergency generator to meet the City's daytime and nighttime Noise Ordinance limit and reduce project operational noise impacts to a less than significant level.

Impact B: **Exposure to Groundborne Noise or Vibration.** Construction-related vibration levels resulting from activities at the project site would exceed 0.25 in/sec PPV at the nearest residential land uses. **This is a less-than-significant impact with the incorporation of mitigation.**

A significant impact would be identified if the construction of the project would generate groundborne vibration levels at adjacent structures exceeding 0.25 in/sec PPV because these levels would have the potential to result in "architectural" damage to normal buildings.

Construction activities would include demolition, excavation, site preparation work, foundation work, new building framing and finishing, and paving. Pile driving is not expected to be needed for project construction. Project construction activities, such as drilling, the use of jackhammers, rock drills and other high-power or vibratory tools, and rolling stock equipment (tracked vehicles, compactors, etc.) may generate substantial vibration in the immediate vicinity of the work area. Vibration levels would vary depending on soil conditions, construction methods, and equipment used. Table 2 presents typical vibration levels that could be expected from construction equipment at a distance of 25 feet. Though existing residential structures are as close as about 20 feet from the perimeter of the project site at the site connection to Melita Road, the closest project structures will be setback 20 to 30 feet from the site perimeter. The majority of site work in all other portions of the site will be 80 feet or more from existing residential structures in the site vicinity.

Based on the levels shown in Table 2, vibration levels produced by 9-ton Vibratory Rollers could reach 0.3 in/sec PPV[1] when operating at 35 feet of adjacent residential structures, and would

[1] These levels are based on calculations assuming normal propagation conditions, using a standard equations of $PPV_{eqmt}=PPV_{ref} * (25/D)^{1.5}$, from FTA, May 2006.

exceed the 0.25 in/sec PPV criterion when operating within 45 feet of an adjacent residential structure. However, the operation of all other expected equipment at 35 feet of adjacent residential structures would result in vibration levels below 0.25 in/sec PPV at the structure. **This is a potentially significant noise impact.**

TABLE 2 Vibration Source Levels for Construction Equipment

Equipment	PPV at 25 feet (in/sec)
Pile Driver (Impact) upper range[1]	1.158
Pile Driver (Impact) typical[1]	0.644
Pile Driver (Sonic) upper range[1]	0.734
Pile Driver (Sonic) typical[1]	0.170
Clam shovel drop	0.202
9-ton Vibratory Roller[2]	0.55
2-ton Vibratory Roller[2]	0.14
Hoe Ram[1]	0.089
Large bulldozer[1]	0.089
Caisson drilling[1]	0.089
Loaded Trucks[1]	0.076
Jackhammer[1]	0.035
Small bulldozer[1]	0.003

1. Source: Federal Transit Administration, 2006
2. Source: Dowding, C.S., Construction Vibrations, Prentice Hall, 1996

Mitigation Measure B: The use of heavy Vibratory Rollers (with weight rating of more than 2 tons) should not be used within 45 feet of any residential property line.

Significance after Mitigation
The implementation of Mitigation Measure B will reduce groundborne vibration levels at adjacent structures to a level below that which would result in "architectural" damage to normal buildings and reduce ground vibration related impacts to a less than significant level.

Impact C: **<u>Substantial Permanent Increase in Ambient Noise Levels</u>.** The operation of the proposed project would generate noise levels exceeding the noise limits established in the City of Santa Rosa General Plan or Noise Ordinance. **This is a less than significant noise impact with the incorporation of Mitigation Measures A1 and A2.**

The proposed project would allow for the expansion of the existing SLV campus with 32 independent living units in 10 buildings and associated community center and outdoor use areas on an undeveloped site approximately 7.28 acre site west of the Hwy 12 and Los Alamos Road intersection near single- and multi-family homes on Montgomery Drive, and Melita and Los Alamos Roads. The occupation and use of these residential units is expected to result in typical noises associated with residential development, such as the voices of the new residents, automobile parking, maintenance activities, and the operation of building mechanical equipment. Vehicular access to the new independent living units would be from Los Alamos Road.

The project traffic report indicates that the project will generate an average of 80 daily vehicle trips, including five during the morning peak hour and six during the evening peak hour. These volumes are significantly lower than the existing or future volumes on the roadways and would result in a less than 1 dBA increase in existing or future roadway noise levels. Therefore, project traffic would not to result in a significant noise increase in noise levels along area roadways. **This is a less than significant impact.**

As discussed under Impact A, the proposed project is expected to include HVAC equipment for the proposed residential and community buildings and the facility will include an emergency generator. As discussed under Impact A, the sound levels due to the operation of the HVAC equipment and the emergency generator were found to exceed the City's Noise Ordinance limits at adjacent residential uses and Mitigations A1 and A2 were developed to reduce equipment sound levels at these adjacent residential properties to a less than significant level. With the incorporation of these measures, no additional mitigation will be needed.

Mitigation Measure C: No additional measures beyond this in Mitigations A1 and A2 are required.

Impact D: **Substantial Temporary Increase in Ambient Noise Levels:** Existing noise-sensitive land uses would be exposed to construction noise levels in excess of the significance thresholds for a period of more than one year and noise levels produced by construction activities may result in interior noise levels within adjacent residences which could result in significant speech interference. **This is a less than significant impact with the incorporation of mitigation.**

Where noise from construction activities exceeds 60 dBA L_{eq} and the ambient noise environment by at least 5 dBA L_{eq} at noise-sensitive uses in the project vicinity for a period which exceeds one year, or where noise levels produced by construction activities result in average noise levels of 65 dBA or maximum noise levels of 75 dBA or more at the exterior of the adjacent residences, the impact would be considered significant.

Noise impacts resulting from construction depends upon the noise generated by various pieces of construction equipment, the timing and duration of noise-generating activities, and the distance between construction noise sources and noise-sensitive areas. Construction noise impacts primarily result when construction activities occur during noise-sensitive times of the day (e.g., early morning, evening, or nighttime hours), the construction occurs in areas immediately adjoining noise-sensitive land uses, or when construction lasts over extended periods of time.

Construction of the project is anticipated to take 18 to 24 months, with work limited to the hours of 8 a.m. to 5 p.m. Monday through Friday and no construction on Saturdays, Sundays, and holidays. It is expected that three to four months of this time will be needed to complete the majority of the site clearing and excavation work. During this time there will be grading and tree removal activities that may come within 20 feet of neighboring single family residences and 80 feet of neighboring multi-family residences across Los Alamos Road. Table 3 presents typical ranges of energy equivalent noise levels (L_{eq}) noise levels at 50 feet for residential and institutional construction. Table 4 shows the maximum noise level for different construction equipment.

Table 3: Typical Ranges of L_{eq} Construction Noise Levels at 50 Feet, dBA

Construction Stage	Domestic Housing		Office Building, Hotel, Hospital, School, Public Works	
	I	II	I	II
Ground Clearing	83	83	84	84
Excavation	88	75	89	79
Foundations	81	81	78	78
Erection	81	65	87	75
Finishing	88	72	89	75
I - All pertinent equipment present at site, **II** - Minimum required equipment present at site.				

Source: U.S.E.P.A., Legal Compilation on Noise, Vol. 1, p. 2-104, 1973.

As determined from Tables 3 and 4, and considering that sound levels at 20 feet may be up to 8 dBA higher than those shown in the tables, average construction noise levels during ground clearing and excavation could reach 83 to 89 dBA (L_{eq}) with maximum noise levels reaching 93 to 98 dBA at the closest residence to the project site. On site construction noise levels would therefore exceed 65 dBA L_{eq} and 75 dBA L_{max} during construction at the closest residences. **This is considered a significant impact, which can be reduced to a less than significant level with the incorporation of mitigation.**

Table 4: Maximum Construction Equipment Noise Levels L_{max} at 50 Feet, dBA

Equipment Category	L_{max} (dBA)[1,2]	Equipment Category	L_{max} (dBA)[1,2]
Arc Welder	73	Horizontal Boring Hydro Jack	80
Auger Drill Rig	85	Hydra Break Ram	90
Backhoe	80	Impact Pile Driver	105
Bar Bender	80	Insitu Soil Sampling Rig	84
Boring Jack Power Unit	80	Jackhammer	85
Chain Saw	85	Mounted Impact Hammer (hoe ram)	90
Compressor[3]	70	Paver	85
Compressor (other)	80	Pneumatic Tools	85
Concrete Mixer	85	Pumps	77
Concrete Pump	82	Rock Drill	85
Concrete Saw	90	Scraper	85
Concrete Vibrator	80	Slurry Trenching Machine	82
Crane	85	Soil Mix Drill Rig	80
Dozer	85	Street Sweeper	80
Excavator	85	Tractor	84
Front End Loader	80	Truck (dump, delivery)	84
Generator	82	Vacuum Excavator Truck (vac-truck)	85
Generator (25 KVA or less)	70	Vibratory Compactor	80
Gradall	85	Vibratory Pile Driver	95
Grader	85	All other equipment with engines larger than 5 HP	85
Grinder Saw	85		

Notes: [1] Measured at 50 feet from the construction equipment, with a "slow" (1 sec.) time constant.

[2] **Noise limits apply to total noise emitted from equipment and associated components operating at full power while engaged in its intended operation.**
[3] **Portable Air Compressor rated at 75 cfm or greater and that operates at greater than 50 psi.**

Additionally, the project would generate construction truck traffic particularly during the three to four month period involved with site clearing and excavation work. During this time heavy duty (semi-tractor trailer type) trucks can be expected on Hwy 12, Los Alamos Road, Melita Road and Montgomery Drive, while smaller medium duty trucks would be expected on area roadways for the remainder of the construction period. Heavy duty trucks typically produce maximum sound levels at 50 feet of 70 dBA when traveling at constant speeds. Medium duty trucks typically produce sound levels at 50 feet of 60 dBA when traveling at constant speeds. Considering these levels and that residences along Los Alamos Road, Melita Road and Montgomery Drive are as close as 30 to 35 feet from the center of roadway travel lanes; heavy trucks traveling at a constant speed may produce maximum sound levels of up to 72 dBA at the residences along these roadways and medium trucks traveling at a constant speed may produce sound levels of up to 62 dBA at the residences along these roadways. Such levels would not exceed the 75 dBA maximum exterior speech interference threshold or be expected to last for a year or more. **Therefore, construction traffic noise is not considered a significant impact.**

Mitigation Measure D:
The applicant shall develop a construction mitigation plan with input from adjacent noise-sensitive land uses so that construction activities can be scheduled to minimize noise disturbances. Considering the potential for substantial increases in noise at adjacent residences as a result of project construction, the following conditions shall be incorporated into contract agreements:

a) Install a temporary construction noise barrier with a height of 8 feet above grade on the project property lines shared with the residential properties to the south and west as shown in Figure 3 before loud construction activities begin and keep in place until construction within 150 feet of the barrier location is complete. The placement of the barriers should not allow clear line of sight, or openings for site access between the site activities and adjacent residential land uses. The barriers may be composed of mass loaded construction blankets on temporary fencing or solid plywood construction barriers and should have a minimum surface weight of 1.0 lb. /ft^2 and an equivalent STC rating of 25 or more.
b) Muffle and maintain all equipment used on site. All internal combustion engine-driven equipment shall be fitted with mufflers, which are in good condition. Good mufflers shall result in non-impact tools generating a maximum noise level of 80 dB when measured at a distance of 50 feet.
c) Utilize "quiet" models of air compressors and other stationary noise sources where technology exists.
d) Locate stationary noise-generating equipment as far as possible from sensitive receptors when sensitive receptors adjoin or are near a construction project area.
e) Prohibit unnecessary idling of internal combustion engines.
f) Prohibit construction workers' radios which are audible on adjoining properties.
g) Restrict noise-generating construction activities at the site or in areas adjacent to the construction site to the hours between 8:00 a.m. and 5:00 p.m., Monday through Friday.
h) Do not allow machinery to be cleaned or serviced past 6:00 p.m. or prior to 8:00 a.m. Monday through Friday

i) Limit the allowable hours for the delivery of materials or equipment to the site and truck traffic coming to and from the site for any purpose to Monday through Friday between 8:00 a.m. and 6:00 p.m.
j) Do not allow any construction or construction-related activities at the project site on Weekends and holidays.
k) Allowable construction hours shall be posted clearly on a sign at the construction site.
l) The construction contractor shall designate a "noise disturbance coordinator" who will be responsible for responding to any local complaints about construction noise. A telephone number for the disturbance coordinator shall be conspicuously posted at the construction site. The Disturbance Coordinator shall:
    1. Receive and act on complaints about construction disturbances during site clearing, excavation, infrastructure installation, road building, residential construction, and site other construction activities.
    2. Determine the cause(s) and implement remedial measures as necessary to alleviate significant problems.
    3. Clearly post his/her name and phone number(s) on a sign at the construction site.
    4. Notify area residents of construction activities, schedules, and potential impacts.

Significance after Mitigation
The implementation of the noise barriers, source noise control, and operational restrictions in Mitigation Measure D is expect to reduce average (L_{eq}) construction related noise levels by 25 dBA to levels of less than 65 dBA levels at exterior areas of residential uses in the project vicinity and maximum (L_{max}) construction related noise levels to less than 75 dBA at the exterior facades of residences in the project vicinity and reduce construction related noise impacts to a less than significant level.

CUMULATIVE NOISE IMPACTS
Based on a review and analysis of future and project traffic projections contained in the project traffic study (dated 9-19-17) indicates that project related traffic would result in no increase the noise environment on the project site and surroundings properties adjacent to Hwy 12 and a 0.1 dBA increase the noise environment on the project site and surroundings properties adjacent to Los Alamos Road. With the incorporation of Mitigation Measures A1 and A2 operational noise from the project would comply with the City's Noise Ordinance limits at the adjacent residential uses. Furthermore, once the project is completed, it's occupation and use would be expected to result in the typical noises associated with residential and institutional development, which are considered to be compatible with the surrounding residential and institutional land uses. Based on these conclusions, the project would not produce any cumulative noise impacts on the surrounding residential land uses.

Figure 3: Location of Construction Noise Barriers for Either Development Scheme

APPENDIX A:
FUNDAMENTAL CONCEPTS OF ENVIRONMENTAL ACOUSTICS

Noise may be defined as unwanted sound. Noise is usually objectionable because it is disturbing or annoying. The objectionable nature of sound may be caused by either its *pitch* or its loudness. *Pitch* is the height or depth of a tone or sound, depending on the relative rapidity (frequency) of the vibrations by which it is produced. Higher pitched signals sound louder to humans than sounds with a lower pitch. *Loudness* is intensity of sound waves combined with the reception characteristics of the ear. Intensity may be compared with the height of an ocean wave in that it is a measure of the amplitude of the sound wave.

In addition to the concepts of pitch and loudness, there are several noise measurement scales that are used to describe noise in a particular location. A decibel (dB) is a unit of measurement that indicates the relative amplitude of a sound. The zero on the decibel scale is based on the lowest sound level that the healthy, unimpaired human ear can detect. Sound levels in decibels are calculated on a logarithmic basis. An increase of 10 decibels represents a ten-fold increase in acoustic energy, while 20 decibels is 100 times more intense, 30 decibels is 1,000 times more intense, etc. There is a relationship between the subjective noisiness or loudness of a sound and its intensity. Each 10-decibel increase in sound level is perceived as approximately a doubling of loudness over a fairly wide range of intensities. For lesser increases of sound from the same or similar sources, a 6 dB change is perceived to be a "noticeable" change and a 3 dB change to be just perceptible. Technical terms are defined in Table 1. There are several methods of characterizing sound. The most common in California is the A-weighted sound level or dBA. This scale gives greater weight to the frequencies of sound to which the human ear is most sensitive. Representative outdoor and indoor noise levels in units of dBA are shown in Table 2.

Because sound levels can vary markedly over a short period of time, a method for describing either the average character of the sound or the statistical behavior of the variations must be utilized. Most commonly, environmental sounds are described in terms of an average level that has the same acoustical energy as the summation of all the time-varying events. This energy-equivalent sound/noise descriptor is called L_{eq}. The most common averaging period is hourly, but L_{eq} can describe any series of noise events of arbitrary duration.

The scientific instrument used to measure noise is the sound level meter. Sound level meters can accurately measure environmental noise levels to within about plus or minus 1 dBA. Various computer models are used to predict environmental noise levels from sources, such as roadways and airports. The accuracy of the predicted models depends upon the distance the receptor is from the noise source. Close to the noise source, the models are accurate to within about plus or minus 1 to 2 dBA.

Since the sensitivity to noise increases during the evening and at night -- because excessive noise interferes with the ability to sleep -- 24-hour descriptors have been developed that incorporate artificial noise penalties added to quiet-time noise events. The Day/Night Average Sound Level, Ldn, is a measure of the cumulative noise exposure in a community, with a 10 dB penalty added to nighttime (10:00 pm - 7:00 am) noise levels. The Community Noise Equivalent Level, CNEL, is a measure of the cumulative noise exposure in a community, with a 5 dB penalty added to evening (7:00 pm - 10:00 pm) and a 10 dB addition to nocturnal (10:00 pm - 7:00 am) noise levels.

TERM	DEFINITIONS
Decibel, dB	A unit describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure, which is 20 micropascals (20 micronewtons per square meter).
Frequency, Hz	The number of complete pressure fluctuations per second above and below atmospheric pressure.
A-Weighted Sound Level, dBA	The sound pressure level in decibels as measured on a sound level meter using the A-weighting filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise. All sound levels in this report are A-weighted, unless reported otherwise.
L_{01}, L_{10}, L_{50}, L_{90}	The A-weighted noise levels that are exceeded 1%, 10%, 50%, and 90% of the time during the measurement period.
Equivalent Noise Level, L_{eq}	The average A-weighted noise level during the measurement period.
Day/Night Noise Level, L_{dn}	The average A-weighted noise level during a 24-hour day, obtained after addition of 10 decibels to levels measured in the night between 10:00 pm and 7:00 am.
Community Noise Equivalent Level, CNEL	The average A-weighted noise level during a 24-hour day, obtained after addition of 5 decibels in the evening from 7:00 pm to 10:00 pm and after addition of 10 decibels to sound levels in the night between 10:00 pm and 7:00 am.
L_{max}, L_{min}	The maximum and minimum A-weighted noise level during the measurement period.
Ambient Noise Level	The composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location.
Intrusive	That noise which intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends upon its amplitude, duration, frequency, and time of occurrence and tonal or informational content as well as the prevailing ambient noise level.

Definitions Of Acoustical Terms **Table 1**

ILLINGWORTH & RODKIN, INC. /Acoustical Engineers

Effects of Noise

Sleep and Speech Interference: The thresholds for speech interference indoors are about 45 dBA if the noise is steady and above 55 dBA if the noise is fluctuating. With intruding noise at 45 dBA conversations at normal vocal levels could be held between two persons at a distance about 10 feet (or across a typical room in a residential setting) and with intruding noise at 55 dBA conversations at normal vocal levels could be held between two persons at a distance of about 3 feet[2] (or the typical distance of persons sitting or standing near one another).

[2] Kryter Karl D., The effects of Noise on Man, Second Edition, Academic Press, Inc. London, 1985, Table 4.4, p.96

Outdoors the thresholds are about 15 dBA higher. Steady noise of sufficient intensity; above 35 dBA, and fluctuating noise levels above about 45 dBA have been shown to affect sleep. Interior residential standards for multi-family dwellings are set by the State of California at 45 dBA L_{dn}. Typically, the highest steady traffic noise level during the daytime is about equal to the L_{dn} and nighttime levels are 10 dBA lower. The standard is designed for sleep and speech protection and most jurisdictions apply the same criterion for all residential uses.

Noise Source (Given Distance)	A-Weighted Sound Level	Noise Environments	Subjective Impression
	140		
Civil Defense Siren (100')	130		
Jet Takeoff (200')	120		Pain Threshold
	110	Rock Music Concert	
Diesel Pile Driver (100')	100		Very Loud
	90	Boiler Room	
Freight Cars (50')		Printing Press Plant	
Pneumatic Drill (50')	80		
Freeway (100')		In Kitchen With Garbage	
Vacuum Cleaner (10')	70	Disposal Running	Moderately Loud
	60	Data Processing Center	
Light Traffic (100')	50	Department Store	
Large Transformer (200')			
	40	Private Business Office	Quiet
Soft Whisper (5')	30	Quiet Bedroom	
	20	Recording Studio	
	10		Threshold of Hearing
	0		

Typical Sound Levels in the Environment & Industry **Table 2**

ILLINGWORTH & RODKIN, INC. ***/Acoustical Engineers***

Typical structural attenuation is 12-17 dBA with open windows. With closed windows in good condition, the noise attenuation factor is around 20 dBA for an older structure and 25 dBA for a newer dwelling. Sleep and speech interference is therefore possible when exterior noise levels are about 57-62 dBA with open windows and 65-70 dBA if the windows are closed.

Annoyance: Attitude surveys are used for measuring the annoyance felt in a community for noises intruding into homes or affecting outdoor activity areas. In these surveys, it was determined that the causes for annoyance include interference with speech, radio and television, house vibrations, and interference with sleep and rest. The Ldn as a measure of noise has been found to provide a valid correlation of noise level and the percentage of people annoyed. People have been asked to judge the annoyance caused by aircraft noise and ground transportation noise. There continues to be disagreement about the relative annoyance of these different sources. When measuring the percentage of the population highly annoyed, the threshold for ground vehicle noise is about 55 dBA Ldn. At an Ldn of about 60 dBA, approximately 2 percent of the population is highly annoyed. When the Ldn increases to 70 dBA, the percentage of the population highly annoyed increases to about 12 percent of the population. There is, therefore, an increase of about 1 percent per dBA between an Ldn of 60-70 dBA. Between an Ldn of 70-80 dBA, each decibel increase increases by about 2 percent the percentage of the population highly annoyed.

Appendix G –Traffic Impact Study

January 31, 2020

Mr. Kevin Gerber
Covia Communities
2185 N. California Boulevard, Suite 215
Walnut Creek, CA 94596

Addendum to the *Traffic Study for the Spring Lake Village East Grove Project*

Dear Mr. Gerber;

As requested, this addendum to the *Traffic Impact Study for the Spring Lake Village East Grove Project* (TIS), September 19, 2017, has been prepared to address changes that have been made to the site plan since our study was completed in 2017. The Spring Lake Village East Grove project is proposed to be located on Los Alamos Road in the City of Santa Rosa.

Effect on Traffic Impact Study Findings

It is understood that the changes to the project are primarily related to siting of buildings and on-site drive aisles; the number of units has not changed nor has the proposed access location. As the number of units is the foundation of the traffic impact analysis, no changes would be required to the traffic study to assess project-related impacts to off-site transportation facilities. The analysis of the project as now proposed would essentially be identical to that presented in the TIS, especially considering that the Future scenario was based on 2040 model volumes and this remains the horizon year of the currently available model data. It is noted that based on the most recent edition of the *Trip Generation Manual* the project's trip generation would be lower on a daily basis as well as during both peaks, making the analysis slightly conservative. Similarly, it is understood that the driveway location is unchanged, so issues such as sight distance and turning movements would be unchanged from what is presented in the TIS. Based on our review, it is concluded that the TIS remains valid for the project as currently proposed.

VMT

The Vehicle Miles Traveled (VMT) for the proposed development were estimated by multiplying the average trip length by the project's daily trip generation estimate. The average trip length is calculated by land use type and destination in the Sonoma County Transportation Authority (SCTA) Model. The project traffic analysis zone (TAZ) has a daily VMT of 5.63 miles per trip. For the 80 daily trips that the 32 units are anticipated to generate, the resulting VMT is 450.4.

The project will house active seniors, and adequate facilities to allow them to walk or bicycle between the project site and the main campus of Spring Lake Village are being provided as part of the project. Further, shuttle service is to be provided that would allow residents to make many of their off-site trips, such as for medical appointments and shopping, in multi-passenger vehicles. Similarly, a shuttle service between the project site and the main campus would accommodate short trips that might otherwise be made by private vehicle. The project as proposed incorporates an adequate TDM. As a result of these measures, it is reasonable to conclude that the project will have a less-than-significant impact on VMT.

We hope this information adequately addresses how the changes to the project affect the traffic analysis previously prepared based on a different site plan. Thank you for giving us the opportunity to provide these services.

Sincerely,

Dalene J. Whitlock, PE, PTOE
Senior Principal

DJW/djw/SRO355-1.L1

Copy to: Ms. Michelle Gervais, Gervais & Associates (via email to Michelle@GervaisAssociates.com)
Ms. Susan Rockwood, Rockwood Pacific (via email to Susan@rockwoodpacific.com)

Traffic Impact Study for the Spring Lake Village East Grove Project

Prepared for the City of Santa Rosa

Submitted by
W-Trans

September 19, 2017

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Executive Summary

The proposed Spring Lake Village East Grove project includes 32 new independent living units, with two potential combinations of residences. The proposed project also includes a sidewalk connection to the intersection of Montgomery Drive/Melita Road where pedestrian access would be provided to the existing Spring Lake Village complex. The project's anticipated trip generation includes 80 daily trips on average, with 5 trips during the weekday a.m. peak hour and 6 trips during p.m. peak hour.

The study area includes the intersection of State Route (SR) 12/Los Alamos Road and the segments of SR 12 between Mountain Hawk Way and Los Alamos Road, Los Alamos Road between SR 12 and Melita Road, Melita Road between Los Alamos Road and Montgomery Road, and Montgomery Road between Melita Road and Channel Drive. Analysis indicates that the study intersection is expected to operate at an acceptable level of service upon the addition of project-generated traffic to both existing and future volumes, resulting in a less-than-significant traffic impact.

Similarly, pedestrian, bicycle and transit access are all expected to be adequate upon completion of currently planned facilities as well as those proposed as part of the project and as future improvements. Completion of the proposed pedestrian improvements along Los Alamos Road, Montgomery Drive, and the crosswalk at the Montgomery Drive/Melita Road intersection will provide adequate pedestrian access to the existing Spring Lake Village main campus as well as the transit stop located at the SR 12/Los Alamos Road intersection. Implementation of the City's Bicycle and Pedestrian Master Plan, and completion of the proposed Class II bicycle lane along Los Alamos Road would link the project site to the surrounding bicycle network, and racks to accommodate ten bicycles will be provided on-site. However, appropriate signage should be provided to warn bicyclists of the end of the bike lane near the project site's southern boundary on Los Alamos Road.

Vehicles will access the project site via a new driveway on Los Alamos Road. Sight distance at the driveway is expected to be adequate for the posted speed limit on Los Alamos Road in both directions, but sight distance to the north could be improved with the trimming or removal of a bush that appears to be in road right-of-way. Any signs or landscaping installed near the driveway should be low-lying or set-back so that they do not impact the availability of clear sight lines.

Introduction

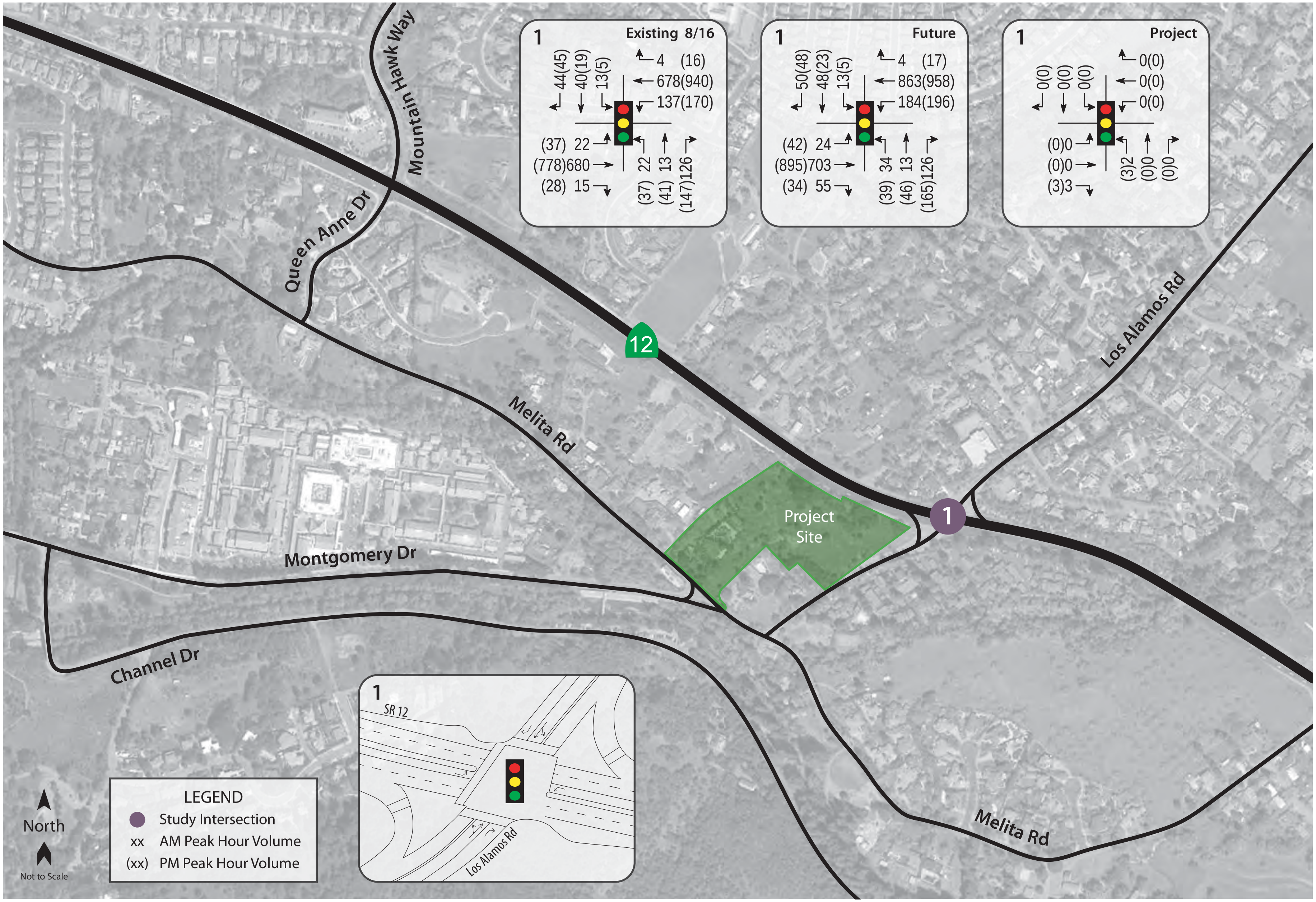
This report presents an analysis of the potential traffic impacts that would be associated with development of a proposed 32-unit senior housing development to be located on the west side of Los Alamos Road between SR 12 and Melita Road in the City of Santa Rosa. The traffic study was completed in accordance with the criteria established by the City of Santa Rosa, and is consistent with standard traffic engineering techniques. Issues raised by residents of the area during public meetings regarding the project were considered during the preparation of this study.

Prelude

The purpose of a traffic impact study is to provide City staff and policy makers with data that they can use to make an informed decision regarding the potential traffic impacts of a proposed project, and any associated improvements that would be required in order to mitigate these impacts to a level of insignificance as defined by the City's General Plan or other policies. Vehicular traffic impacts are typically evaluated by determining the number of new trips that the proposed use would be expected to generate, distributing these trips to the surrounding street system based on existing travel patterns or anticipated travel patterns specific to the proposed project, then analyzing the impact the new traffic would be expected to have on critical intersections or roadway segments. Impacts relative to access for pedestrians, bicyclists, and to transit are also addressed.

Project Profile

The proposed project includes 32 new independent living units. There are 20 units in duplex "cottage" buildings and 12 units in a two-story villa in the "Original Modified" site plan, while the "Project Alternative" includes 18 duplex "cottage" units and 14 units in the multi-story villa. Parking would be provided by 32 surface spaces for the "Original Modified Plan" while the "Project Alternative" would have 15 surface parking spaces and 21 spaces in the garage at the villa. Further, each cottage unit would have a two-car garage. Ten bicycle parking spaces will be provided in two racks. Site access would be via a driveway on Los Alamos Road. The proposed project also includes a sidewalk connection to the intersection of Montgomery Drive/Melita Road where pedestrian access would be provided to the existing Spring Lake Village complex. Additionally, residents would be able to access the existing Spring Lake Village complex via shuttle which would run daily every 30 minutes between the hours of 7:00 a.m. and 9:00 p.m. The location of the project site is shown in Figure 1.



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Traffic Impact Study for the Spring Lake Village East Grove Project

Figure 1 – Study Area, Lane Configuration, and Traffic Volumes

Transportation Setting

Operational Analysis

Study Area and Periods

The intersection of SR 12/Los Alamos Road was included in the operational analysis. Operating conditions during the a.m. and p.m. peak periods were evaluated to capture the highest potential impacts for the proposed project as well as the highest volumes on the local transportation network. The morning peak period occurs between 7:00 and 9:00 a.m. and reflects conditions during the home to work or school commute, while the p.m. peak period occurs between 4:00 and 6:00 p.m. and typically reflects the highest level of congestion during the homeward bound commute. At the study intersection, the weekday a.m. peak hour occurred between 8:00 and 9:00 a.m. and the p.m. peak hour occurred between 4:00 and 5:00 p.m.

Additionally, the following adjacent roadway segments were evaluated in terms of geometrics and access for alternative modes:

1. SR 12 – Mountain Hawk Way to Los Alamos Road
2. Los Alamos Road – SR 12 to Melita Road
3. Melita Road – Los Alamos Road to Montgomery Road
4. Montgomery Road – Melita Road to Channel Drive

Study Intersections

SR 12/Los Alamos Road is a signalized four-way intersection with channelized right-turn lanes and left-turn pockets with protected left-turn phasing on the eastbound and westbound approaches. Marked crosswalks are present on the southbound, eastbound, and northbound approaches. The location of the study intersection along with the existing lane configuration and control are shown in Figure 1.

Study Roadways

SR 12 between Mountain Hawk Way and Los Alamos Road is a four-lane highway running southeast-northwest with a two lanes in each direction and a 15-foot wide planted median separating the directions of travel. The roadway segment has 12-foot wide lanes and 8-foot shoulders in both directions and a posted speed limit of 55 miles per hour (mph).

Los Alamos Road between SR 12 and Melita Road runs northeast-southwest along the project frontage and has a 15-foot travel lane in each direction with a posted speed limit of 35 mph. The project driveway would be located on the west side of Los Alamos Road.

Melita Road between Los Alamos Road and Montgomery Road runs east-west and is only 350 feet in length. The roadway segment has two travel lanes within the 25-foot paved width.

Montgomery Road between Melita Road and Channel Drive runs east-west and has two travel lanes with a posted speed limit of 40 mph. The roadway is 40 feet wide and has marked bicycle lanes in both directions.

Collision History

The collision history for the study area was reviewed to determine any trends or patterns that may indicate a safety issue. Collision rates were calculated based on records available from the California Highway Patrol as published in their Statewide Integrated Traffic Records System (SWITRS) reports. The most current five-year period available is May 1, 2011 through April 30, 2016.

Calculated collision rates for the study intersection and the study roadway segments were compared to average collision rates for similar facilities statewide, as indicated in *2013 Collision Data on California State Highways*, California Department of Transportation (Caltrans). The average collision rates for intersections differ based on whether the intersection is controlled by a traffic signal, all-way stop signs, or is uncontrolled, as well as the number of approaches (three or four). Average collision rates for roadway segments are provided based on the number of lanes, design speed, and presence of a median.

As presented in Table 1, the study intersection had a collision rate below the statewide average for signalized four-way intersections, which indicates the intersection is performing acceptably with regards to safety. Similarly, all three of the study segments have collision rates that are lower than the average rates for similar facilities. The collision rate calculations for the study intersection as well as the study roadway segments are provided in Appendix A.

Table 1 – Summary of Collision Rates

Study Intersection	Number of Collisions (2011-2016)	Calculated Collision Rate (c/mve)	Statewide Average Collision Rate (c/mve)
1. SR 12/Los Alamos Rd	12	0.29	0.43
Study Segment	**Number of Collisions (2010-2015)**	**Calculated Collision Rate (c/mvm)**	**Statewide Average Collision Rate (c/mvm)**
1. SR 12 – Mtn Hawk Way to Los Alamos Rd	18	0.86	1.45
2. Los Alamos Rd – SR 12 to Melita Rd	1	0.60	2.21
3. Montgomery Dr/Melita Rd – Channel Dr to Los Alamos Rd	7	0.82	2.21

Note: c/mve = collisions per million vehicles entering; c/mvm = collisions per million vehicle miles

Alternative Modes

Pedestrian Facilities

Pedestrian facilities include sidewalks, crosswalks, pedestrian signal phases, curb ramps, curb extensions, and various streetscape amenities such as lighting, benches, etc. In general, the vicinity of the project site is lacking pedestrian facilities. Gaps in existing sidewalks along the connecting roadways impact convenient and continuous access for pedestrians and present safety concerns in those locations where appropriate pedestrian infrastructure would address potential conflict points.

- **SR 12** – Significant gaps in sidewalk connectivity exist on both sides of the highway between Mountain Hawk Way and Los Alamos Road. Curb ramps and crosswalks at side-street approaches are intermittent and may not be compliant with current ADA standards. Intermittent lighting is provided by overhead street lights.

- **Los Alamos Road** – Intermittent sidewalk coverage is provided on the east side of Los Alamos Road in front of Villa Los Alamos and no sidewalk coverage is provided on the west side along the proposed project site frontage. There are no street lights on this road.

- **Melita Road** – There are no sidewalks or streetlights present on either side of the roadway between Los Alamos Road and Montgomery Road.

- **Montgomery Road** – Connected sidewalks are present on the north side of Montgomery Road between approximately 675 feet west of the Montgomery Road/Melita Road intersection and the western property edge of the existing Spring Lake Village main complex.

- **Los Alamos Road/Melita Road** – is an all-way stop-controlled tee intersection with no crosswalks or street lighting provided on any legs.

- **Montgomery Road/Melita Road** – is a tee-intersection stop controlled on the southbound Melita Road approach. No crosswalks or streetlights exist at this intersection.

Bicycle Facilities

The *Highway Design Manual*, Caltrans, 2012, classifies bikeways into three categories:

- **Class I Multi-Use Path** – a completely separated right-of-way for the exclusive use of bicycles and pedestrians with cross flows of motorized traffic minimized.
- **Class II Bike Lane** – a striped and signed lane for one-way bike travel on a street or highway.
- **Class III Bike Route** – signing only for shared use with motor vehicles within the same travel lane on a street or highway.

Guidance for Class IV Bikeways is provided in *Design Information Bulletin Number 89: Class IV Bikeway Guidance (Separated Bikeways/Cycle Tracks)*, Caltrans, 2015.

- **Class IV Bikeway** – also known as a separated bikeway, a Class IV Bikeway is for the exclusive use of bicycles and includes a separation between the bikeway and the motor vehicle traffic lane. The separation (or, "buffer") may include, but is not limited to, grade separation, flexible posts, inflexible physical barriers, or on-street parking.

In the project study area, Class II bike lanes exist on Montgomery Drive between Melita Road and Channel Drive. Bicyclists ride in the roadway and/or on sidewalks along all other streets within the project study area. Table 2 summarizes the existing and planned bicycle facilities in the project vicinity, as contained in the 2010 *Santa Rosa Bicycle and Pedestrian Master Plan*.

Table 2 – Bicycle Facility Summary

Status Facility	Class	Length (miles)	Begin Point	End Point
Existing				
Montgomery Dr	II	0.80	Melita Rd	Spring Lake Ct
Planned				
SR 12	II	6.60	City Limits	4th St
Los Alamos Rd	II	0.20	SR 12	Melita Rd

Source: *Santa Rosa Bicycle and Pedestrian Master Plan*, City of Santa Rosa, 2010

Transit Facilities

Sonoma County Transit (SCT) provides fixed route bus service in Sonoma County. SCT Route 30 provides transit service between Santa Rosa and Sonoma seven days a week and stops at the SR 12/Los Alamos Road intersection, approximately 500 feet from the proposed project driveway.

All SCT buses are equipped with racks that can hold two or three bikes. Bicycle rack space is on a first come, first served basis. Additional bicycles are allowed on SCT buses at the discretion of the driver.

Dial-a-ride, also known as paratransit, or door-to-door service, is available for those who are unable to independently use the transit system due to a physical or mental disability. SCT Paratransit is designed to serve the needs of individuals with disabilities within Santa Rosa and the greater Sonoma County area. Paratransit service is available between 5:00 a.m. and 11:00 p.m. Monday through Friday and between 7:00 a.m. and 9:00 p.m. on Saturday and Sunday.

Additionally, the project would provide a shuttle service between the proposed Spring Lake Village East Grove campus and the main campus located on Montgomery Drive for use by all Spring Lake Village residents. The service is expected to run daily every 30 minutes between the hours of 7:00 a.m. and 9:00 p.m. Finally, a shuttle service is also provided from the main campus to take residents to and from medical appointments, shopping destinations, the SMART train and other points of interest. Residents of the Spring Lake Village East Grove project would have access to this existing shuttle service.

Capacity Analysis

Intersection Level of Service Methodologies

Level of Service (LOS) is used to rank traffic operation on various types of facilities based on traffic volumes and roadway capacity using a series of letter designations ranging from A to F. Generally, Level of Service A represents free flow conditions and Level of Service F represents forced flow or breakdown conditions. A unit of measure that indicates a level of delay generally accompanies the LOS designation.

The study intersection was analyzed using the "signalized" methodology published in the *Highway Capacity Manual* (HCM), Transportation Research Board, 2000. This source contains methodologies for various types of intersection control, all of which are related to a measurement of delay in average number of seconds per vehicle. The signalized methodology is based on factors including traffic volumes, green time for each movement, phasing, whether or not the signals are coordinated, truck traffic, and pedestrian activity. Average stopped delay per vehicle in seconds is used as the basis for evaluation in this LOS methodology. For purposes of this study, delays were calculated using optimized signal timing.

The ranges of delay associated with the various levels of service are indicated in Table 3

Table 3 – Signalized Intersection Level of Service Criteria	
LOS A	Delay of 0 to 10 seconds. Most vehicles arrive during the green phase, so do not stop at all.
LOS B	Delay of 10 to 20 seconds. More vehicles stop than with LOS A, but many drivers still do not have to stop.
LOS C	Delay of 20 to 35 seconds. The number of vehicles stopping is significant, although many still pass through without stopping.
LOS D	Delay of 35 to 55 seconds. The influence of congestion is noticeable, and most vehicles have to stop.
LOS E	Delay of 55 to 80 seconds. Most, if not all, vehicles must stop and drivers consider the delay excessive.
LOS F	Delay of more than 80 seconds. Vehicles may wait through more than one cycle to clear the intersection.

Reference: *Highway Capacity Manual*, Transportation Research Board, 2000

Traffic Operation Standards

City of Santa Rosa

The City of Santa Rosa's adopted Level of Service (LOS) Standard is contained in *Santa Rosa General Plan 2035*. Standard TD-1 states that the City will try to maintain a Level of Service (LOS) D or better along all major corridors. Exceptions to meeting this standard are allowed where attainment would result in significant environmental degradation; where topography or environmental impacts make the improvement impossible; or where attainment would ensure loss of an area's unique character.

While a corridor level of service is applied by the City in its analysis of the entire City as part of the environmental documentation supporting the General Plan, this type of analysis only provides relevant data when performed on much longer segments than those included in the study area for this project. Therefore, although the City's standard does not specify criteria for intersections, for the purposes of this study a minimum operation of LOS D for the overall operation of signalized intersections was applied.

Caltrans

Because the study intersection is on a state highway, it is under the jurisdiction of Caltrans. Based on their guidelines, Caltrans indicates that they endeavor to maintain operation at the transition from LOS C to LOS D.

Existing Conditions

The Existing Conditions scenario provides an evaluation of current operation based on existing traffic volumes during the a.m. and p.m. peak periods. This condition does not include project-generated traffic volumes. Volume data was collected at the study intersection on August 2, 2016.

Intersection Levels of Service

Under existing conditions, the study intersection is operating acceptably during the a.m. and p.m. peak hours. The existing traffic volumes are shown in Figure 1. A summary of the intersection level of service calculations is contained in Table 4, and copies of the Level of Service calculations for all evaluated scenarios are provided in Appendix B.

Table 4 – Existing Peak Hour Intersection Levels of Service

	AM Peak		PM Peak	
	Delay	**LOS**	**Delay**	**LOS**
1. SR 12/Los Alamos Rd	13.7	B	14.9	B

Notes: Delay is measured in average seconds per vehicle; LOS = Level of Service

Future Conditions

Segment volumes for the horizon year of 2040 were obtained from the County's gravity demand model maintained by the Sonoma County Transportation Authority (SCTA) and translated to peak hour turning movement volumes at the study intersection using the "Furness" method. The Furness method is an iterative process that employs existing turn movement data, existing link volumes and future link volumes to project likely turning future movement volumes at intersections.

Under the anticipated Future volumes, the study intersection is expected to continue operating acceptably during both peak hours. Future volumes are shown in Figure 1 and operating conditions are summarized in Table 5.

Table 5 – Future Peak Hour Intersection Levels of Service

	AM Peak		PM Peak	
	Delay	**LOS**	**Delay**	**LOS**
1. SR 12/Los Alamos Rd	14.6	B	16.0	B

Notes: Delay is measured in average seconds per vehicle; LOS = Level of Service

Project Description

The proposed project includes 32 new independent living units. The "Original Modified" site plan includes 20 units in duplex "cottage" buildings and the remaining 12 units in a two-story villa. The "Project Alternative" would have 18 duplex "cottage" units and 14 units in the multi-story villa. While the mix of units is slightly different between the two alternatives, from a trip generation and traffic impact perspective, the two options are identical, so only one "plus Project" analysis was performed.

Site access for both options would be provided via a single driveway on Los Alamos Road. Both project options also include a proposed sidewalk connection to the intersection of Montgomery Drive/Melita Road where pedestrian access would be provided to the existing Spring Lake Village complex. The proposed project site plans are shown in Figure 2 and Figure 3.

Trip Generation

The anticipated trip generation resulting from the expansion project was developed based on standard trip generation rates as published in *Trip Generation Manual*, 9th Edition, 2012, by the Institute of Transportation Engineers (ITE). The "Continuing Care Retirement Community" land use (LU #255) was used as the best characterization of the future land use for Spring Lake Village East Grove. This land use reflects the different elements of senior adult living that allow residents to live in one community and age in place as their medical needs change. It also reflects the presence of medical, dining, and recreational facilities present on the existing Spring Lake Village campus. Using these land use assumptions, the project would be expected to generate an average of five new trips during the a.m. peak hour and six new trips during the p.m. peak hour, as shown in Table 6.

Table 6 – Trip Generation Summary

Land Use	Units	Daily		AM Peak Hour				PM Peak Hour			
		Rate	Trips	Rate	Trips	In	Out	Rate	Trips	In	Out
Continuing Care Retirement Community	32 du	2.50	80	0.15	5	3	2	0.20	6	3	3

Note: du = dwelling unit

It should be noted that the ITE rates were previously compared to actual traffic volumes that were surveyed entering and exiting the existing Spring Lake Village facility, and as the actual counts were lower than the trip generation projected using theoretical rates, were determined to be conservative in estimating traffic for the proposed use. Further, because a shuttle service between the site and the Spring Lake Village complex and from there to destinations throughout Santa Rosa is included as part of the proposed project, several passenger vehicle trips would be replaced by a single shuttle trip, resulting in fewer trips overall compared to what was estimated using the standard ITE rates. ITE rates were used in the analysis to be conservative.

Trip Distribution

It is anticipated that many of the project-generated trips would be between the proposed site and the existing Spring Lake Village main campus. However, in an effort to provide conservative potential results for the operational analysis of the study intersection it was assumed that all trips would be to/from SR 12 west of Los Alamos Road.

Vehicle Miles Traveled

Consideration was given to the project's potential to increase Vehicle Miles Traveled (VMT) over conditions without the project. Most of the trips associated with the development would likely be made by employees or visitors, with minimal trips made by residents. By placing the development near an existing senior housing complex, most of the amenities that would generate additional trips, such as field trips, doctor visits, and many of the caregivers, already exist but would be used more efficiently by serving a slightly higher population of senior citizens.

Source: Perkins Eastman 8/17

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Figure 2 – Site Plan: Original Modified Plan

Source: Perkins Eastman 8/17

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Traffic Impact Study for the Spring Lake Village East Grove Project

Figure 3 – Site Plan: Project Alternative

W-Trans

Sonoma County Transportation Authority (SCTA) has developed a model with average trip lengths generated by specific areas of development within the county, known as Traffic Analysis Zones (TAZs). The proposed project would be located in TAZ 663, which generates trips with an average length of 5.63 miles. Based on this data, and the fact that the project is estimated to generate 80 trips on a daily basis, the project would be responsible for 450 vehicle miles traveled per day. However, that this estimate would likely be high as the proposed shuttle service between the project site and the existing Spring Lake Village complex is estimated to reduce the trip generating potential of the project.

Intersection Operation

Existing plus Project Conditions

Upon the addition of project-related traffic to the Existing volumes, the study intersection is expected to continue operating acceptably at LOS B during both peak hours, with only a 0.1-second increase in average delay. These results are summarized in Table 7. Project traffic volumes are shown in Figure 1.

Table 7 – Existing and Existing plus Project Peak Hour Intersection Levels of Service

	Existing Conditions				Existing plus Project			
	AM Peak		PM Peak		AM Peak		PM Peak	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
1. SR 12/Los Alamos Rd	13.7	B	14.9	B	13.7	B	15.0	B

Notes: Delay is measured in average seconds per vehicle; LOS = Level of Service

Finding – The study intersection is expected to continue operating acceptably at the same levels of service and with an imperceptible change in average delay upon the addition of project-generated traffic.

Future plus Project Conditions

Upon the addition of project-generated traffic to the anticipated Future volumes, the study intersection is expected to continue operating acceptably. The Future plus Project operating conditions are summarized in Table 8.

Table 8 – Future and Future plus Project Peak Hour Levels of Service

	Future Conditions				Future plus Project			
	AM Peak		PM Peak		AM Peak		PM Peak	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
1. SR 12/Los Alamos Rd	14.6	B	16.0	B	14.7	B	16.0	B

Notes: Delay is measured in average seconds per vehicle; LOS = Level of Service

Finding – The study intersection will continue operating acceptably with project traffic added, at the same Levels of Service as without it. Again, the anticipated change in average delay would be imperceptible, and the project's impact is less-than-significant.

Alternative Modes

Pedestrian Facilities

Given the proximity of the project site to the transit stop located at the SR 12/Los Alamos Road intersection, it is reasonable to assume that some project residents and employees will want to use transit to reach the project site. Additionally, some residents will want to walk between the project site and the existing Spring Lake Village main complex and/or to Spring Lake Park.

Proposed pedestrian facility improvements would include a publicly accessible off-street pedestrian path along Los Alamos Road adjacent to the project site within the City's right-of-way, effectively linking the project site to the SCT stop at SR 12/Los Alamos Road. The proposed project would also include a sidewalk connection to the intersection of Montgomery Drive/Melita Road where a crosswalk with a center island refuge would be provided to connect to Montgomery Drive. These improvements are shown in Figure 4. Planned future sidewalk improvements on the north side of Montgomery Drive would connect the crosswalk to the existing sidewalk along Montgomery Drive and provide pedestrian access to the Spring Lake Village main complex.

It is noted that while sidewalks do not currently exist along Los Alamos Road, the project would provide a connection to SR 12, and thereby to transit access. Most pedestrian trips would be between this site and Spring Lake Village, and full pedestrian connectivity would be provided along this path. The project is not expected to generate pedestrian trips along Los Alamos Road to the south of the site, so does not impact this road segment or contribute to its deficient state.

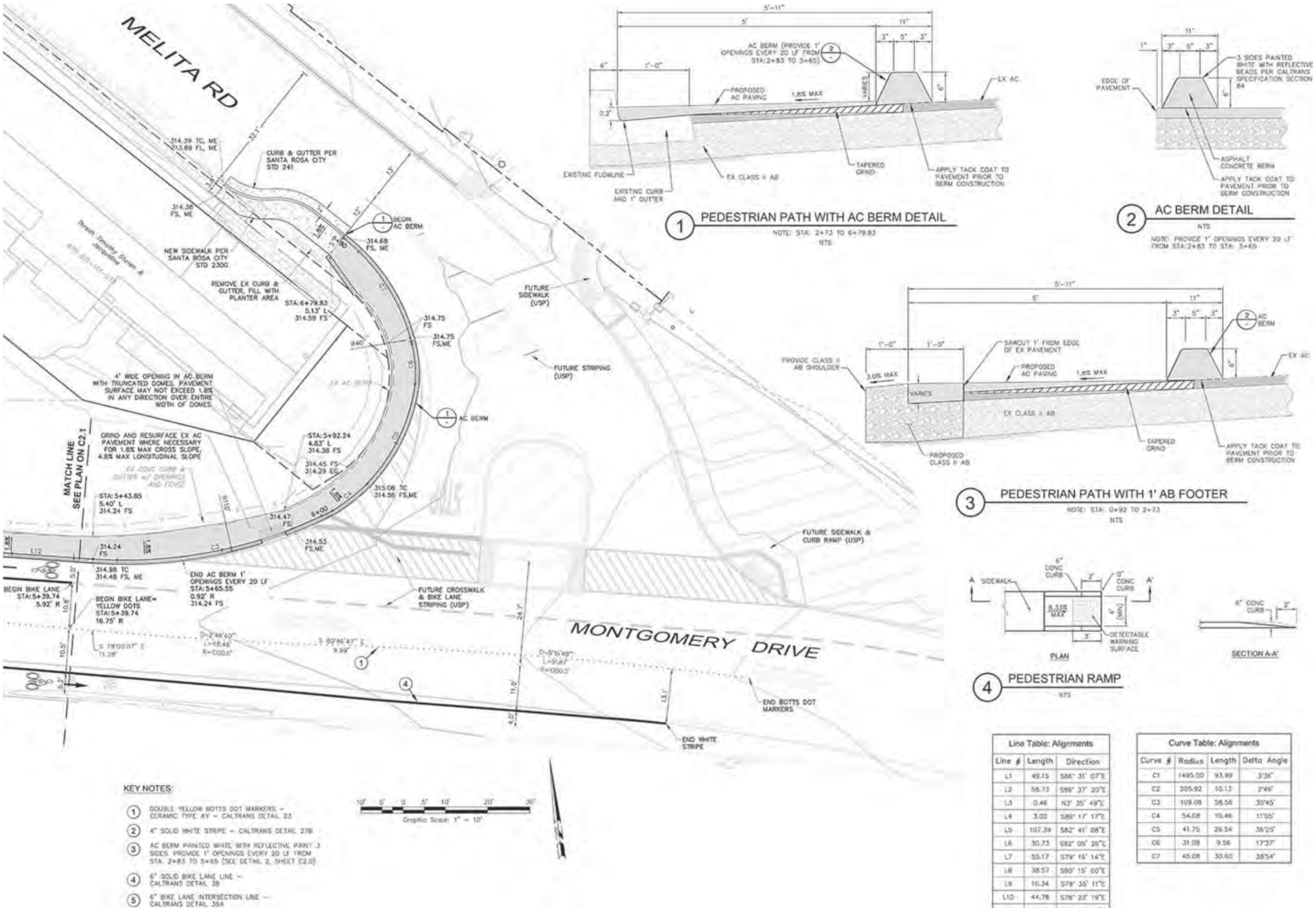
In response to citizen input consideration was given to installing a crosswalk on Los Alamos Road at the Villa Los Alamos. However, a minimal number of pedestrians and cyclists would be expected to use a crosswalk at this location. Installation of a crosswalk where it is unprotected can be appropriate if there is a large demand, resulting in sufficient use that drivers are aware of the potential for activity. Given that very low demand is expected, this would be an inappropriate location for a crosswalk and one is not recommended.

Finding – Pedestrian facilities serving the project site would be adequate upon completion of the planned and proposed improvements.

Bicycle Facilities

Proposed off-site bicycle facility improvements along Los Alamos Road would include the widening and re-striping of the road along the project frontage to provide a 5-foot Class II bicycle lane consistent with the City of Santa Rosa *Bicycle and Pedestrian Master Plan*. The proposed bicycle lane would begin at SR 12 and terminate at the project site's southern property boundary. Existing bicycle facilities along Montgomery Road together with the proposed improvements along Los Alamos Road and the shared use of minor streets provide adequate access for bicyclists in the project area.

The project site is expected to generate minimal bicycle trips, and those can easily be accommodated by the proposed on- and off-site improvements. Further improvements are not necessary to address project impacts or needs. While the project as proposed would result in a bike lane that ends mid-block, this situation is not uncommon in areas where not all properties are fully developed. It is reasonable to conclude that the bike lane will be extended further upon development of other properties adjacent to Los Alamos Road. However, because the bike lane would end mid-block, signage may be appropriate to notify both riders and drivers of this condition.



Line Table: Alignments		
Line #	Length	Direction
L1	49.15	S86° 31' 07"E
L2	58.73	S86° 37' 20"E
L3	0.46	N3° 35' 49"E
L4	3.00	S86° 17' 17"E
L5	107.39	S82° 41' 08"E
L6	30.73	S82° 05' 26"E
L7	55.17	S79° 16' 14"E
L8	38.57	S80° 15' 00"E
L9	10.34	S79° 35' 11"E
L10	44.78	S78° 23' 19"E
L11	14.91	S78° 00' 09"E
L12	26.89	S78° 51' 22"E

Curve Table: Alignments			
Curve #	Radius	Length	Delta Angle
C1	1495.00	93.99	3°36'
C2	205.92	10.13	2°49'
C3	109.08	58.56	30°45'
C4	54.08	10.46	11°05'
C5	41.75	26.54	36°25'
C6	31.08	9.56	17°37'
C7	45.08	33.60	38°54'

Source: Perkins Eastman 8/17

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Figure 4 – Montgomery Lane Pedestrian Path Improvements

Bicycle Storage

It is understood that a total of ten bicycle parking spaces are to be provided in two racks. Per the City of Santa Rosa's Zoning Code (Standard 20-36.040), one bicycle space is required per eight senior housing units, if units do not have a private garage or private bicycle storage space. Residents of the cottage units would be able to use their garages as bicycle storage facilities so they do not require extra bicycle parking. However, in order to satisfy City code the bike rack should have space for at least two bicycles for use by residents of the villa units.

Finding – Bicycle facilities serving the project site would be adequate upon completion of the proposed Class II bicycle lane along Los Alamos Road and provision of bike racks with at least two spaces.

Recommendation – The City should consider requiring installation of signage to warn bicyclists of the end of the bike lane along Los Alamos Road.

Transit

Existing transit routes are adequate to accommodate project-generated transit trips. Existing stops are within acceptable walking distance of the site and continuous sidewalks would be provided by the project.

Finding – Transit facilities serving the project site are adequate.

Access and Circulation

Site Access

Access to the site is proposed via one driveway to be located on the west side of Los Alamos Road approximately 450 feet south of SR 12. The main drive aisle would split into a circular drive that surrounds the pool and common areas in the middle of the site. Individual driveways connecting to the main drive aisle would provide access to the cottages as well as the villa building. As proposed in the conceptual development plan, on-site circulation and access would operate acceptably.

Sight Distance

Sight distance along Los Alamos Road at the site's proposed driveway location was evaluated based upon sight distance criteria contained in the *Highway Design Manual*, 6^{th} Edition, by Caltrans. Criterion based on stopping sight distance was applied. The posted speed limit on Los Alamos Road within proximity of the project site is 35 mph. For a conservative analysis minimum required sight distance was based on a design speed of 40 mph, requiring sight distance of 300 feet.

Field measurements indicate that sight distance exceeds 400 feet looking toward the south. Looking north toward Highway 12 there is a bush that appears to be in the road right-of-way that would need to be cut back or removed to achieve clear sight lines greater than approximately 315 feet, though approaching traffic can be seen from 400 feet away by looking past the bush. It is recommended that the bush be trimmed or removed, if possible, to improve clear sight lines. Planned project frontage improvements, such as vegetation, should be low lying or, if trees, have branches no lower than seven feet.

Finding – Sight distances along Los Alamos Road at the project driveway are adequate to accommodate speeds of 40 mph, however sight distance to the north is compromised by a bush that appears to be in the road right-of-way, though it may need to be removed to accommodate planned frontage improvements.

Recommendation – To achieve clear sight lines greater than approximately 315 feet to the north, it is recommended that the bush be trimmed or removed.

Emergency Access

As proposed the site would be served by a single primary access point, which is reasonable given the limited number of units proposed. Although the City Street Design Standards do not require a secondary access point for developments with less than 50 residential units, a secondary emergency-only access would be provided along the pedestrian pathway connecting to Melita Road.

Finding – Emergency access is expected to operate acceptably.

Parking

The project, as proposed, includes 18 to 20 cottage units, each with a two-car garage. The 12 to 14 villa units (apartments) as well as guests would be served by surface or garage parking, depending on the alternative. In addition to the garages, site parking for the "Original Modified" plan would include 36 surface parking spaces, while the scheme proposed for the "Project Alternative" has 19 surface spaces and 21 spaces in a garage at the villa. The total parking supply would therefore include 76 spaces for either alternative. Per Section 20-36.040 of the City of Santa Rosa Zoning Code, the project is required to provide one space per unit plus one guest space for every ten units, or 32 spaces for the units plus three for guests for a total supply of 35. The proposed parking supply exceeds that required under City standards.

Finding – The proposed parking satisfies City standards and is adequate for the facility.

Conclusions and Recommendations

Conclusions

- The proposed project is expected to generate an average of 80 daily vehicle trips, including five during the morning peak hour and six during the evening peak hour.
- The study intersection of SR 12/Los Alamos Road is currently operating acceptably at LOS B during both peak hours. Upon the addition of project-related traffic to the Existing volumes, the study intersection is expected to continue operating acceptably at LOS B during both peak hours.
- Under anticipated Future volumes, the study intersection is expected to continue operating acceptably at LOS B during both peak hours and upon adding project-generated traffic.
- Pedestrian, bicycle, and transit facilities would adequately serve the site upon completion of the planned and proposed improvements along Los Alamos Road, Montgomery Road, and at the intersection of Montgomery Road/Melita Road as well as provision of bike racks. Planned pedestrian facilities, in particular, will allow easy access to the Spring Lake Village main complex.
- Sight distances along Los Alamos Road at the project driveway are adequate to accommodate speeds of 40 mph; however, sight distance to the north is compromised by a bush that appears to be in the road right-of-way.
- On-site circulation and emergency access are expected to operate acceptably.
- The proposed parking supply satisfies City standards and is adequate for the facility.

Recommendations

- Appropriate signage should be considered to warn bicyclists of the end of the bike lane on Los Alamos Road.
- To achieve clear sight lines to the north of the project driveway, the bush located north of the driveway should be trimmed or removed.
- Any new landscaping at the project driveway should be planted and maintained such that it is less than three feet, or more than seven feet, in height to maximize clear sight lines.

Study Participants and References

Study Participants

Principal in Charge	Dalene J. Whitlock, PE, PTOE
Assistant Engineer	Cameron Nye, EIT
Assistant Engineer	Allison Jaromin, EIT
Graphics/Editing/Formatting	Angela McCoy

References

2013 Collision Data on California State Highways, California Department of Transportation, 2012
California Department of Transportation Traffic Census Program, http://www.dot.ca.gov/trafficops/census/
Design Information Bulletin Number 89: Class IV Bikeway Guidance (Separated Bikeways/Cycle Tracks), California Department of Transportation, 2015
Highway Capacity Manual, Transportation Research Board, 2000
Highway Design Manual, 6th Edition, California Department of Transportation, 2012
Santa Rosa Bicycle and Pedestrian Master Plan, City of Santa Rosa, 2010
Santa Rosa City Code, Quality Code Publishing, 2015
Santa Rosa General Plan 2035, City of Santa Rosa, 2014
Sonoma County Transit, http://sctransit.com/maps-schedules/
Statewide Integrated Traffic Records System (SWITRS), California Highway Patrol, 2010-2015
Traffic Counts 2015, City of Santa Rosa, http://ci.santa-rosa.ca.us/doclib/Documents/Trafficcounts15.pdf
Trip Generation Manual, 9th Edition, Institute of Transportation Engineers, 2012

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Appendix A

Collision Rate Calculations

Intersection Collision Rate Calculations

Spring Lake Village East Grove

Intersection # 1: SR 12 & Los Alamos
Date of Count: Tuesday, August 02, 2016

Number of Collisions: 12
Number of Injuries: 10
Number of Fatalities: 0
ADT: 22600
Start Date: May 1, 2011
End Date: April 30, 2016
Number of Years: 5

Intersection Type: Four-Legged
Control Type: Signals
Area: Suburban

$$\text{collision rate} = \frac{\text{Number of Collisions x 1 Million}}{\text{ADT x 365 Days per Year x Number of Years}}$$

$$\text{collision rate} = \frac{12 \quad x \quad 1{,}000{,}000}{22{,}600 \quad x \quad 365 \quad x \quad 5}$$

	Collision Rate		Fatality Rate	Injury Rate
Study Intersection	**0.29**	**c/mve**	**0.0%**	**83.3%**
Statewide Average*	**0.43**	**c/mve**	**0.4%**	**37.9%**

ADT = average daily total vehicles entering intersection
c/mve = collisions per million vehicles entering intersection
* 2012 Collision Data on California State Highways, Caltrans

SEGMENT COLLISION RATE CALCULATIONS

Spring Lake Village East Grove

Location: SR 12 -- Mountain Hawk to Los Alamos Rd

Date of Count: Tuesday, August 02, 2016
ADT: 20,500

Number of Collisions: 18
Number of Injuries: 15
Number of Fatalities: 0
Start Date: May 1, 2011
End Date: April 30, 2016
Number of Years: 5

Highway Type: Divided 4 lanes
Area: Urban
Design Speed: >45

Segment Length: 0.6 miles
Direction: East/West

$$\frac{\text{Number of Collisions x 1 Million}}{\text{ADT x 365 Days per Year x Segment Length x Number of Years}}$$

$$\frac{18 \times 1{,}000{,}000}{20{,}500 \times 365 \times 0.56 \times 5}$$

	Collision Rate	Fatality Rate	Injury Rate
Study Segment	**0.86 c/mvm**	**0.0%**	**83.3%**
Statewide Average*	**1.45 c/mvm**	**0.7%**	**40.8%**

ADT = average daily traffic volume
c/mvm = collisions per million vehicle miles
* 2012 Collision Data on California State Highways, Caltrans

Location: Los Alamos Rd -- SR 12 to Melita Rd

Date of Count: Tuesday, August 02, 2016
ADT: 4,600

Number of Collisions: 1
Number of Injuries: 0
Number of Fatalities: 0
Start Date: May 1, 2011
End Date: April 30, 2016
Number of Years: 5

Highway Type: Conventional 2 lanes or less
Area: Urban
Design Speed: ≤45

Segment Length: 0.2 miles
Direction: North/South

$$\frac{\text{Number of Collisions x 1 Million}}{\text{ADT x 365 Days per Year x Segment Length x Number of Years}}$$

$$\frac{1 \times 1{,}000{,}000}{4{,}600 \times 365 \times 0.2 \times 5}$$

	Collision Rate	Fatality Rate	Injury Rate
Study Segment	**0.60 c/mvm**	**0.0%**	**0.0%**
Statewide Average*	**2.21 c/mvm**	**0.8%**	**36.6%**

ADT = average daily traffic volume
c/mvm = collisions per million vehicle miles
* 2012 Collision Data on California State Highways, Caltrans

SEGMENT COLLISION RATE CALCULATIONS

Spring Lake Village East Grove

Location: Montgomery Dr/Melita Rd -- Channel Dr to Los Alamos Rd
Date of Count: Tuesday, August 02, 2016
ADT: 7,400

Number of Collisions: 7
Number of Injuries: 4
Number of Fatalities: 0
Start Date: May 1, 2011
End Date: April 30, 2016
Number of Years: 5

Highway Type: Conventional 2 lanes or less
Area: Urban
Design Speed: ≤45

Segment Length: 0.6 miles
Direction: East/West

$$\frac{\text{Number of Collisions} \times 1\ \text{Million}}{\text{ADT} \times 365\ \text{Days per Year} \times \text{Segment Length} \times \text{Number of Years}}$$

$$\frac{7 \times 1{,}000{,}000}{7{,}400 \times 365 \times 0.63 \times 5}$$

	Collision Rate		Fatality Rate	Injury Rate
Study Segment	**0.82**	**c/mvm**	**0.0%**	**57.1%**
Statewide Average*	**2.21**	**c/mvm**	**0.8%**	**36.6%**

ADT = average daily traffic volume
c/mvm = collisions per million vehicle miles
* 2012 Collision Data on California State Highways, Caltrans

Appendix B

Intersection Level of Service Calculations

Intersection Level Of Service Report
Intersection 1: State Route 12/Los Alamos Road

Control Type	Signalized	Delay (sec / veh)	13.7
Analysis Method	HCM 2010	Level Of Service	B
Analysis Period	15 minutes	Volume to Capacity (v/c)	0.631

Intersection Setup

Name	Los Alamos Rd			Los Alamos Rd			SR 12			SR 12		
Approach	Northbound			Southbound			Eastbound			Westbound		
Lane Configuration												
Turning Movement	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
Lane Width [ft]	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
No. of Lanes in Pocket	0	0	1	0	0	1	1	0	1	1	0	1
Pocket Length [ft]	100.00	100.00	125.00	100.00	100.00	125.00	325.00	100.00	160.00	285.00	100.00	200.00
Speed [mph]	35.00			35.00			55.00			55.00		
Grade [%]	0.00			0.00			0.00			0.00		
Crosswalk	Yes			Yes			Yes			No		

volumes

Name	Los Alamos Rd			Los Alamos Rd			SR 12			SR 12		
Base Volume Input [veh/h]	22	13	126	13	40	44	22	680	15	137	678	4
Base Volume Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Heavy Vehicles Percentage [%]	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Growth Rate	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
In-Process Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Site-Generated Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Diverted Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Pass-by Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Existing Site Adjustment Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Other Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Right-Turn on Red Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Total Hourly Volume [veh/h]	22	13	126	13	40	44	22	680	15	137	678	4
Peak Hour Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Other Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Total 15-Minute Volume [veh/h]	6	3	32	3	10	11	6	170	4	34	170	1
Total Analysis Volume [veh/h]	22	13	126	13	40	44	22	680	15	137	678	4
Presence of On-Street Parking	No		No	No		No	No		No	No		No
On-Street Parking Maneuver Rate [/h]	0	0	0	0	0	0	0	0	0	0	0	0
Local Bus Stopping Rate [/h]	0	0	0	0	0	0	0	0	0	0	0	0
Pedestrian Volume [ped/h]	0			0			0			0		
Bicycle Volume [bicycles/h]	0			0			0			0		

Intersection Settings

Located in CBD	No
Signal Coordination Group	-
Cycle Length [s]	60
Coordination Type	Time of Day Pattern Isolated
Actuation Type	Fully actuated
Offset [s]	0.0
Offset Reference	LeadGreen
Permissive Mode	SingleBand
Lost time [s]	12.00

Phasing & Timing

Control Type	Permiss	Permiss	Permiss	Permiss	Permiss	Permiss	Protecte	Permiss	Permiss	Protecte	Permiss	Permiss
Signal group	0	2	0	0	6	0	3	8	0	7	4	0
Auxiliary Signal Groups												
Lead / Lag	-	-	-	-	-	-	Lead	-	-	Lead	-	-
Minimum Green [s]	0	5	0	0	5	0	5	5	0	5	5	0
Maximum Green [s]	0	30	0	0	30	0	30	30	0	30	30	0
Amber [s]	0.0	3.0	0.0	0.0	3.0	0.0	3.0	3.0	0.0	3.0	3.0	0.0
All red [s]	0.0	1.0	0.0	0.0	1.0	0.0	1.0	1.0	0.0	1.0	1.0	0.0
Split [s]	0	19	0	0	19	0	21	19	0	22	20	0
Vehicle Extension [s]	0.0	3.0	0.0	0.0	3.0	0.0	3.0	3.0	0.0	3.0	3.0	0.0
Walk [s]	0	5	0	0	5	0	0	5	0	0	5	0
Pedestrian Clearance [s]	0	10	0	0	10	0	0	10	0	0	10	0
l1, Start-Up Lost Time [s]	0.0	2.0	0.0	0.0	2.0	0.0	2.0	2.0	0.0	2.0	2.0	0.0
l2, Clearance Lost Time [s]	0.0	2.0	0.0	0.0	2.0	0.0	2.0	2.0	0.0	2.0	2.0	0.0
Minimum Recall		No			No		No	No		No	No	
Maximum Recall		No			No		No	No		No	No	
Pedestrian Recall		No			No		No	No		No	No	
Detector Location [ft]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Detector Length [ft]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I, Upstream Filtering Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Exclusive Pedestrian Phase

Pedestrian Signal Group	0
Pedestrian Walk [s]	0
Pedestrian Clearance [s]	0

Lane Group Calculations

Lane Group	C	R	C	R	L	C	R	L	C	R
L, Total Lost Time per Cycle [s]	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
l1_p, Permitted Start-Up Lost Time [s]	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
l2, Clearance Lost Time [s]	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
g_i, Effective Green Time [s]	15	15	15	15	2	27	27	6	32	32
g / C, Green / Cycle	0.25	0.25	0.25	0.25	0.03	0.45	0.45	0.10	0.53	0.53
(v / s)_i Volume / Saturation Flow Rate	0.24	0.08	0.08	0.03	0.01	0.19	0.01	0.08	0.19	0.00
s, saturation flow rate [veh/h]	148	1583	677	1583	1774	3547	1583	1774	3547	1583
c, Capacity [veh/h]	134	391	242	391	45	1604	716	178	1870	835
d1, Uniform Delay [s]	18.88	18.47	18.24	17.49	28.84	11.13	9.08	26.31	8.29	6.72
k, delay calibration	0.37	0.11	0.11	0.11	0.11	0.50	0.50	0.11	0.50	0.50
I, Upstream Filtering Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
d2, Incremental Delay [s]	3.45	0.47	0.45	0.13	7.80	0.82	0.05	6.81	0.55	0.01
d3, Initial Queue Delay [s]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rp, platoon ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
PF, progression factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Lane Group Results

X, volume / capacity	0.26	0.32	0.22	0.11	0.48	0.42	0.02	0.77	0.36	0.00
d, Delay for Lane Group [s/veh]	22.32	18.94	18.69	17.61	36.64	11.96	9.14	33.12	8.84	6.73
Lane Group LOS	C	B	B	B	D	B	A	C	A	A
Critical Lane Group	Yes	No	No	No	No	Yes	No	Yes	No	No
50th-Percentile Queue Length [veh]	0.46	1.34	0.54	0.44	0.37	2.34	0.09	1.97	1.77	0.02
50th-Percentile Queue Length [ft]	11.61	33.49	13.59	10.99	9.26	58.53	2.21	49.15	44.23	0.45
95th-Percentile Queue Length [veh]	0.84	2.41	0.98	0.79	0.67	4.21	0.16	3.54	3.18	0.03
95th-Percentile Queue Length [ft]	20.90	60.29	24.47	19.78	16.67	105.36	3.98	88.47	79.61	0.81

Movement, Approach, & Intersection Results

d_M, Delay for Movement [s/veh]	22.32	22.32	18.94	18.69	18.69	17.61	36.64	11.96	9.14	33.12	8.84	6.73
Movement LOS	C	C	B	B	B	B	D	B	A	C	A	A
d_A, Approach Delay [s/veh]	19.68			18.20			12.65			12.89		
Approach LOS	B			B			B			B		
d_I, Intersection Delay [s/veh]	13.69											
Intersection LOS	B											
Intersection V/C	0.631											

Sequence

Ring 1	2	3	4	-	-	-	-	-	-	-	-	-	-	-	-	-
Ring 2	6	7	8	-	-	-	-	-	-	-	-	-	-	-	-	-
Ring 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ring 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Intersection Level Of Service Report
Intersection 1: State Route 12/Los Alamos Road

Control Type	Signalized	Delay (sec / veh)	14.9
Analysis Method	HCM 2010	Level Of Service	B
Analysis Period	15 minutes	Volume to Capacity (v/c)	0.471

Intersection Setup

Name	Los Alamos Rd			Los Alamos Rd			SR 12			SR 12		
Approach	Northbound			Southbound			Eastbound			Westbound		
Lane Configuration												
Turning Movement	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
Lane Width [ft]	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
No. of Lanes in Pocket	0	0	1	0	0	1	1	0	1	1	0	1
Pocket Length [ft]	100.00	100.00	125.00	100.00	100.00	125.00	325.00	100.00	160.00	285.00	100.00	200.00
Speed [mph]	35.00			35.00			55.00			55.00		
Grade [%]	0.00			0.00			0.00			0.00		
Crosswalk	Yes			Yes			Yes			No		

volumes

Name	Los Alamos Rd			Los Alamos Rd			SR 12			SR 12		
Base Volume Input [veh/h]	37	41	147	5	19	45	37	778	28	170	940	16
Base Volume Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Heavy Vehicles Percentage [%]	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Growth Rate	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
In-Process Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Site-Generated Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Diverted Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Pass-by Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Existing Site Adjustment Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Other Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Right-Turn on Red Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Total Hourly Volume [veh/h]	37	41	147	5	19	45	37	778	28	170	940	16
Peak Hour Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Other Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Total 15-Minute Volume [veh/h]	9	10	37	1	5	11	9	195	7	43	235	4
Total Analysis Volume [veh/h]	37	41	147	5	19	45	37	778	28	170	940	16
Presence of On-Street Parking	No		No	No		No	No		No	No		No
On-Street Parking Maneuver Rate [/h]	0	0	0	0	0	0	0	0	0	0	0	0
Local Bus Stopping Rate [/h]	0	0	0	0	0	0	0	0	0	0	0	0
Pedestrian Volume [ped/h]	0			0			0			0		
Bicycle Volume [bicycles/h]	0			0			0			0		

Intersection Settings

Located in CBD	No
Signal Coordination Group	-
Cycle Length [s]	90
Coordination Type	Time of Day Pattern Isolated
Actuation Type	Fully actuated
Offset [s]	0.0
Offset Reference	LeadGreen
Permissive Mode	SingleBand
Lost time [s]	12.00

Phasing & Timing

Control Type	Permiss	Permiss	Permiss	Permiss	Permiss	Permiss	Protecte	Permiss	Permiss	Protecte	Permiss	Permiss
Signal group	0	2	0	0	6	0	3	8	0	7	4	0
Auxiliary Signal Groups												
Lead / Lag	-	-	-	-	-	-	Lead	-	-	Lead	-	-
Minimum Green [s]	0	5	0	0	5	0	5	5	0	5	5	0
Maximum Green [s]	0	30	0	0	30	0	30	30	0	30	30	0
Amber [s]	0.0	3.0	0.0	0.0	3.0	0.0	3.0	3.0	0.0	3.0	3.0	0.0
All red [s]	0.0	1.0	0.0	0.0	1.0	0.0	1.0	1.0	0.0	1.0	1.0	0.0
Split [s]	0	22	0	0	22	0	14	45	0	23	54	0
Vehicle Extension [s]	0.0	3.0	0.0	0.0	3.0	0.0	3.0	3.0	0.0	3.0	3.0	0.0
Walk [s]	0	5	0	0	5	0	0	5	0	0	5	0
Pedestrian Clearance [s]	0	10	0	0	10	0	0	10	0	0	10	0
l1, Start-Up Lost Time [s]	0.0	2.0	0.0	0.0	2.0	0.0	2.0	2.0	0.0	2.0	2.0	0.0
l2, Clearance Lost Time [s]	0.0	2.0	0.0	0.0	2.0	0.0	2.0	2.0	0.0	2.0	2.0	0.0
Minimum Recall		No			No		No	No		No	No	
Maximum Recall		No			No		No	No		No	No	
Pedestrian Recall		No			No		No	No		No	No	
Detector Location [ft]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Detector Length [ft]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I, Upstream Filtering Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Exclusive Pedestrian Phase

Pedestrian Signal Group	0
Pedestrian Walk [s]	0
Pedestrian Clearance [s]	0

Lane Group Calculations

Lane Group	C	R	C	R	L	C	R	L	C	R
L, Total Lost Time per Cycle [s]	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
l1_p, Permitted Start-Up Lost Time [s]	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
l2, Clearance Lost Time [s]	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
g_i, Effective Green Time [s]	10	10	10	10	3	57	57	11	64	64
g / C, Green / Cycle	0.12	0.12	0.12	0.12	0.03	0.63	0.63	0.12	0.72	0.72
(v / s)_i Volume / Saturation Flow Rate	0.06	0.09	0.01	0.03	0.02	0.22	0.02	0.10	0.27	0.01
s, saturation flow rate [veh/h]	1217	1583	1726	1583	1774	3547	1583	1774	3547	1583
c, Capacity [veh/h]	201	184	249	184	61	2243	1001	209	2538	1133
d1, Uniform Delay [s]	37.80	38.75	35.61	36.18	42.85	7.79	6.19	38.75	4.95	3.68
k, delay calibration	0.11	0.11	0.11	0.11	0.11	0.50	0.50	0.11	0.50	0.50
I, Upstream Filtering Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
d2, Incremental Delay [s]	1.23	7.67	0.17	0.68	9.13	0.43	0.05	7.42	0.42	0.02
d3, Initial Queue Delay [s]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rp, platoon ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
PF, progression factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Lane Group Results

X, volume / capacity	0.39	0.80	0.10	0.24	0.60	0.35	0.03	0.81	0.37	0.01
d, Delay for Lane Group [s/veh]	39.03	46.41	35.78	36.86	51.98	8.22	6.24	46.17	5.37	3.70
Lane Group LOS	D	D	D	D	D	A	A	D	A	A
Critical Lane Group	No	Yes	No	No	No	Yes	No	Yes	No	No
50th-Percentile Queue Length [veh]	1.68	3.47	0.47	0.91	0.92	2.70	0.16	3.82	2.11	0.06
50th-Percentile Queue Length [ft]	42.07	86.74	11.83	22.86	22.91	67.60	4.04	95.59	52.77	1.42
95th-Percentile Queue Length [veh]	3.03	6.25	0.85	1.65	1.65	4.87	0.29	6.88	3.80	0.10
95th-Percentile Queue Length [ft]	75.73	156.13	21.29	41.15	41.24	121.68	7.27	172.07	94.98	2.56

Movement, Approach, & Intersection Results

d_M, Delay for Movement [s/veh]	39.03	39.03	46.41	35.78	35.78	36.86	51.98	8.22	6.24	46.17	5.37	3.70
Movement LOS	D	D	D	D	D	D	D	A	A	D	A	A
d_A, Approach Delay [s/veh]	43.85			36.48			10.07			11.50		
Approach LOS	D			D			B			B		
d_I, Intersection Delay [s/veh]	14.95											
Intersection LOS	B											
Intersection V/C	0.471											

Sequence

Ring 1	2	3	4	-	-	-	-	-	-	-	-	-	-	-	-	-
Ring 2	6	7	8	-	-	-	-	-	-	-	-	-	-	-	-	-
Ring 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ring 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Intersection Level Of Service Report
Intersection 1: State Route 12/Los Alamos Road

Control TypeA	Signalized	Delay (sec / veh)A	14.6
Analysis MethodA	HCM 2010	Level Of ServiceA	B
Analysis PeriodA	15 minutes	Volume to Capacity (v/c)A	0.988

Intersection Setup

Name	Los Alamos Rd			Los Alamos Rd			SR 12			SR 12		
Approach	Northbound			Southbound			Eastbound			Westbound		
Lane Configuration												
Turning Movement	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
Lane Width [ft]	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
No. of Lanes in Pocket	0	0	1	0	0	1	1	0	1	1	0	1
Pocket Length [ft]	100.00	100.00	125.00	100.00	100.00	125.00	325.00	100.00	160.00	285.00	100.00	200.00
Speed [mph]	35.00			35.00			55.00			55.00		
Grade [%]	0.00			0.00			0.00			0.00		
Crosswalk	Yes			Yes			Yes			No		

volumes

Name	Los Alamos Rd			Los Alamos Rd			SR 12			SR 12		
Base Volume Input [veh/h]	34	13	126	13	48	50	24	703	55	184	863	4
Base Volume Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Heavy Vehicles Percentage [%]	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Growth Rate	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
In-Process Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Site-Generated Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Diverted Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Pass-by Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Existing Site Adjustment Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Other Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Right-Turn on Red Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Total Hourly Volume [veh/h]	34	13	126	13	48	50	24	703	55	184	863	4
Peak Hour Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Other Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Total 15-Minute Volume [veh/h]	9	3	32	3	12	13	6	176	14	46	216	1
Total Analysis Volume [veh/h]	34	13	126	13	48	50	24	703	55	184	863	4
Presence of On-Street Parking	No		No	No		No	No		No	No		No
On-Street Parking Maneuver Rate [/h]	0	0	0	0	0	0	0	0	0	0	0	0
Local Bus Stopping Rate [/h]	0	0	0	0	0	0	0	0	0	0	0	0
Pedestrian Volume [ped/h]	0			0			0			0		
Bicycle Volume [bicycles/h]	0			0			0			0		

Intersection Settings

Located in CBD	No
Signal Coordination Group	-
Cycle Length [s]	60
Coordination Type	Time of Day Pattern Isolated
Actuation Type	Fully actuated
Offset [s]	0.0
Offset Reference	LeadGreen
Permissive Mode	SingleBand
Lost time [s]	12.00

Phasing & Timing

Control Type	Permiss	Permiss	Permiss	Permiss	Permiss	Permiss	Protecte	Permiss	Permiss	Protecte	Permiss	Permiss
Signal group	0	2	0	0	6	0	3	8	0	7	4	0
Auxiliary Signal Groups												
Lead / Lag	-	-	-	-	-	-	Lead	-	-	Lead	-	-
Minimum Green [s]	0	5	0	0	5	0	5	5	0	5	5	0
Maximum Green [s]	0	30	0	0	30	0	30	30	0	30	30	0
Amber [s]	0.0	3.0	0.0	0.0	3.0	0.0	3.0	3.0	0.0	3.0	3.0	0.0
All red [s]	0.0	1.0	0.0	0.0	1.0	0.0	1.0	1.0	0.0	1.0	1.0	0.0
Split [s]	0	19	0	0	19	0	21	19	0	22	20	0
Vehicle Extension [s]	0.0	3.0	0.0	0.0	3.0	0.0	3.0	3.0	0.0	3.0	3.0	0.0
Walk [s]	0	5	0	0	5	0	0	5	0	0	5	0
Pedestrian Clearance [s]	0	10	0	0	10	0	0	10	0	0	10	0
I1, Start-Up Lost Time [s]	0.0	2.0	0.0	0.0	2.0	0.0	2.0	2.0	0.0	2.0	2.0	0.0
I2, Clearance Lost Time [s]	0.0	2.0	0.0	0.0	2.0	0.0	2.0	2.0	0.0	2.0	2.0	0.0
Minimum Recall		No			No		No	No		No	No	
Maximum Recall		No			No		No	No		No	No	
Pedestrian Recall		No			No		No	No		No	No	
Detector Location [ft]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Detector Length [ft]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I, Upstream Filtering Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Exclusive Pedestrian Phase

Pedestrian Signal Group	0
Pedestrian Walk [s]	0
Pedestrian Clearance [s]	0

Lane Group Calculations

Lane Group	C	R	C	R	L	C	R	L	C	R
L, Total Lost Time per Cycle [s]	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
l1_p, Permitted Start-Up Lost Time [s]	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
l2, Clearance Lost Time [s]	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
g_i, Effective Green Time [s]	15	15	15	15	2	25	25	8	31	31
g / C, Green / Cycle	0.25	0.25	0.25	0.25	0.03	0.42	0.42	0.13	0.52	0.52
(v / s)_i Volume / Saturation Flow Rate	0.49	0.08	0.08	0.03	0.01	0.20	0.03	0.10	0.24	0.00
s, saturation flow rate [veh/h]	96	1583	772	1583	1774	3547	1583	1774	3547	1583
c, Capacity [veh/h]	127	391	263	391	49	1495	667	234	1865	833
d1, Uniform Delay [s]	22.72	18.50	18.23	17.58	28.76	12.52	10.40	25.23	8.91	6.76
k, delay calibration	0.50	0.11	0.11	0.11	0.11	0.50	0.50	0.11	0.50	0.50
I, Upstream Filtering Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
d2, Incremental Delay [s]	8.07	0.47	0.45	0.15	7.49	1.06	0.24	5.78	0.83	0.01
d3, Initial Queue Delay [s]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rp, platoon ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
PF, progression factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Lane Group Results

X, volume / capacity	0.37	0.32	0.23	0.13	0.49	0.47	0.08	0.79	0.46	0.00
d, Delay for Lane Group [s/veh]	30.79	18.97	18.67	17.73	36.26	13.59	10.65	31.00	9.74	6.77
Lane Group LOS	C	B	B	B	D	B	B	C	A	A
Critical Lane Group	Yes	No	No	No	No	Yes	No	Yes	No	No
50th-Percentile Queue Length [veh]	0.92	1.34	0.63	0.50	0.40	2.70	0.37	2.52	2.44	0.02
50th-Percentile Queue Length [ft]	23.05	33.51	15.66	12.55	9.95	67.43	9.17	63.01	61.10	0.45
95th-Percentile Queue Length [veh]	1.66	2.41	1.13	0.90	0.72	4.86	0.66	4.54	4.40	0.03
95th-Percentile Queue Length [ft]	41.50	60.32	28.19	22.59	17.91	121.38	16.50	113.43	109.98	0.81

Movement, Approach, & Intersection Results

d_M, Delay for Movement [s/veh]	30.79	30.79	18.97	18.67	18.67	17.73	36.26	13.59	10.65	31.00	9.74	6.77
Movement LOS	C	C	B	B	B	B	D	B	B	C	A	A
d_A, Approach Delay [s/veh]	22.18			18.25			14.08			13.45		
Approach LOS	C			B			B			B		
d_I, Intersection Delay [s/veh]	14.65											
Intersection LOS	B											
Intersection V/C	0.988											

Sequence

Ring 1	2	3	4	-	-	-	-	-	-	-	-	-	-	-	-	-
Ring 2	6	7	8	-	-	-	-	-	-	-	-	-	-	-	-	-
Ring 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ring 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Intersection Level Of Service Report
Intersection 1: State Route 12/Los Alamos Road

Control Type	Signalized	Delay (sec / veh)	16.0
Analysis Method	HCM 2010	Level Of Service	B
Analysis Period	15 minutes	Volume to Capacity (v/c)	0.539

Intersection Setup

Name	Los Alamos Rd			Los Alamos Rd			SR 12			SR 12		
Approach	Northbound			Southbound			Eastbound			Westbound		
Lane Configuration												
Turning Movement	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
Lane Width [ft]	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
No. of Lanes in Pocket	0	0	1	0	0	1	1	0	1	1	0	1
Pocket Length [ft]	100.00	100.00	125.00	100.00	100.00	125.00	325.00	100.00	160.00	285.00	100.00	200.00
Speed [mph]	35.00			35.00			55.00			55.00		
Grade [%]	0.00			0.00			0.00			0.00		
Crosswalk	Yes			Yes			Yes			No		

volumes

Name	Los Alamos Rd			Los Alamos Rd			SR 12			SR 12		
Base Volume Input [veh/h]	39	46	165	5	23	48	42	895	34	196	958	17
Base Volume Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Heavy Vehicles Percentage [%]	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Growth Rate	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
In-Process Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Site-Generated Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Diverted Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Pass-by Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Existing Site Adjustment Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Other Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Right-Turn on Red Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Total Hourly Volume [veh/h]	39	46	165	5	23	48	42	895	34	196	958	17
Peak Hour Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Other Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Total 15-Minute Volume [veh/h]	10	12	41	1	6	12	11	224	9	49	240	4
Total Analysis Volume [veh/h]	39	46	165	5	23	48	42	895	34	196	958	17
Presence of On-Street Parking	No		No	No		No	No		No	No		No
On-Street Parking Maneuver Rate [/h]	0	0	0	0	0	0	0	0	0	0	0	0
Local Bus Stopping Rate [/h]	0	0	0	0	0	0	0	0	0	0	0	0
Pedestrian Volume [ped/h]	0			0			0			0		
Bicycle Volume [bicycles/h]	0			0			0			0		

Intersection Settings

Located in CBD	No
Signal Coordination Group	-
Cycle Length [s]	90
Coordination Type	Time of Day Pattern Isolated
Actuation Type	Fully actuated
Offset [s]	0.0
Offset Reference	LeadGreen
Permissive Mode	SingleBand
Lost time [s]	12.00

Phasing & Timing

Control Type	Permiss	Permiss	Permiss	Permiss	Permiss	Permiss	Protecte	Permiss	Permiss	Protecte	Permiss	Permiss
Signal group	0	2	0	0	6	0	3	8	0	7	4	0
Auxiliary Signal Groups												
Lead / Lag	-	-	-	-	-	-	Lead	-	-	Lead	-	-
Minimum Green [s]	0	5	0	0	5	0	5	5	0	5	5	0
Maximum Green [s]	0	30	0	0	30	0	30	30	0	30	30	0
Amber [s]	0.0	3.0	0.0	0.0	3.0	0.0	3.0	3.0	0.0	3.0	3.0	0.0
All red [s]	0.0	1.0	0.0	0.0	1.0	0.0	1.0	1.0	0.0	1.0	1.0	0.0
Split [s]	0	22	0	0	22	0	14	45	0	23	54	0
Vehicle Extension [s]	0.0	3.0	0.0	0.0	3.0	0.0	3.0	3.0	0.0	3.0	3.0	0.0
Walk [s]	0	5	0	0	5	0	0	5	0	0	5	0
Pedestrian Clearance [s]	0	10	0	0	10	0	0	10	0	0	10	0
I1, Start-Up Lost Time [s]	0.0	2.0	0.0	0.0	2.0	0.0	2.0	2.0	0.0	2.0	2.0	0.0
I2, Clearance Lost Time [s]	0.0	2.0	0.0	0.0	2.0	0.0	2.0	2.0	0.0	2.0	2.0	0.0
Minimum Recall		No			No		No	No		No	No	
Maximum Recall		No			No		No	No		No	No	
Pedestrian Recall		No			No		No	No		No	No	
Detector Location [ft]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Detector Length [ft]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I, Upstream Filtering Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Exclusive Pedestrian Phase

Pedestrian Signal Group	0
Pedestrian Walk [s]	0
Pedestrian Clearance [s]	0

Generated with PTV VISTRO
Version 4.00-02

Lane Group Calculations

Lane Group	C	R	C	R	L	C	R	L	C	R
L, Total Lost Time per Cycle [s]	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
l1_p, Permitted Start-Up Lost Time [s]	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
l2, Clearance Lost Time [s]	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
g_i, Effective Green Time [s]	11	11	11	11	3	55	55	12	63	63
g / C, Green / Cycle	0.13	0.13	0.13	0.13	0.04	0.61	0.61	0.13	0.70	0.70
(v / s)_i Volume / Saturation Flow Rate	0.05	0.10	0.02	0.03	0.02	0.25	0.02	0.11	0.27	0.01
s, saturation flow rate [veh/h]	1562	1583	1804	1583	1774	3547	1583	1774	3547	1583
c, Capacity [veh/h]	258	202	278	202	66	2149	959	236	2489	1111
d1, Uniform Delay [s]	36.18	38.24	34.77	35.32	42.75	9.36	7.15	38.04	5.49	4.05
k, delay calibration	0.11	0.11	0.11	0.11	0.11	0.50	0.50	0.11	0.50	0.50
I, Upstream Filtering Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
d2, Incremental Delay [s]	0.74	7.77	0.16	0.60	9.75	0.60	0.07	7.34	0.45	0.03
d3, Initial Queue Delay [s]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rp, platoon ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
PF, progression factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Lane Group Results

X, volume / capacity	0.33	0.82	0.10	0.24	0.64	0.42	0.04	0.83	0.38	0.02
d, Delay for Lane Group [s/veh]	36.92	46.00	34.93	35.92	52.50	9.95	7.22	45.38	5.94	4.07
Lane Group LOS	D	D	C	D	D	A	A	D	A	A
Critical Lane Group	No	Yes	No	No	No	Yes	No	Yes	No	No
50th-Percentile Queue Length [veh]	1.74	3.88	0.54	0.96	1.04	3.66	0.22	4.37	2.40	0.07
50th-Percentile Queue Length [ft]	43.50	97.06	13.60	23.99	26.05	91.60	5.52	109.33	59.98	1.66
95th-Percentile Queue Length [veh]	3.13	6.99	0.98	1.73	1.88	6.60	0.40	7.80	4.32	0.12
95th-Percentile Queue Length [ft]	78.30	174.70	24.48	43.18	46.89	164.89	9.93	195.07	107.97	2.99

Generated with PTV VISTRO
Version 4.00-02

Movement, Approach, & Intersection Results

d_M, Delay for Movement [s/veh]	36.92	36.92	46.00	34.93	34.93	35.92	52.50	9.95	7.22	45.38	5.94	4.07
Movement LOS	D	D	D	C	C	D	D	A	A	D	A	A
d_A, Approach Delay [s/veh]	42.91			35.55			11.70			12.51		
Approach LOS	D			D			B			B		
d_I, Intersection Delay [s/veh]	15.98											
Intersection LOS	B											
Intersection V/C	0.539											

Sequence

Ring 1	2	3	4	-	-	-	-	-	-	-	-	-	-	-	-	-
Ring 2	6	7	8	-	-	-	-	-	-	-	-	-	-	-	-	-
Ring 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ring 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Intersection Level Of Service Report
Intersection 1: State Route 12/Los Alamos Road

Control Type:	Signalized	Delay (sec / veh):	13.7
Analysis Method:	HCM 2010	Level Of Service:	B
Analysis Period:	15 minutes	Volume to Capacity (v/c):	0.678

Intersection Setup

Name	Los Alamos Rd			Los Alamos Rd			SR 12			SR 12		
Approach	Northbound			Southbound			Eastbound			Westbound		
Lane Configuration												
Turning Movement	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
Lane Width [ft]	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
No. of Lanes in Pocket	0	0	1	0	0	1	1	0	1	1	0	1
Pocket Length [ft]	100.00	100.00	125.00	100.00	100.00	125.00	325.00	100.00	160.00	285.00	100.00	200.00
Speed [mph]	35.00			35.00			55.00			55.00		
Grade [%]	0.00			0.00			0.00			0.00		
Crosswalk	Yes			Yes			Yes			No		

Volumes

Name	Los Alamos Rd			Los Alamos Rd			SR 12			SR 12		
Base Volume Input [veh/h]	22	13	126	13	40	44	22	680	15	137	678	4
Base Volume Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Heavy Vehicles Percentage [%]	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Growth Rate	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
In-Process Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Site-Generated Trips [veh/h]	2	0	0	0	0	0	0	0	3	0	0	0
Diverted Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Pass-by Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Existing Site Adjustment Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Other Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Right-Turn on Red Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Total Hourly Volume [veh/h]	24	13	126	13	40	44	22	680	18	137	678	4
Peak Hour Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Other Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Total 15-Minute Volume [veh/h]	6	3	32	3	10	11	6	170	5	34	170	1
Total Analysis Volume [veh/h]	24	13	126	13	40	44	22	680	18	137	678	4
Presence of On-Street Parking	No		No	No		No	No		No	No		No
On-Street Parking Maneuver Rate [/h]	0	0	0	0	0	0	0	0	0	0	0	0
Local Bus Stopping Rate [/h]	0	0	0	0	0	0	0	0	0	0	0	0
Pedestrian Volume [ped/h]	0			0			0			0		
Bicycle Volume [bicycles/h]	0			0			0			0		

Intersection Settings

Located in CBD	No
Signal Coordination Group	-
Cycle Length [s]	60
Coordination Type	Time of Day Pattern Isolated
Actuation Type	Fully actuated
Offset [s]	0.0
Offset Reference	LeadGreen
Permissive Mode	SingleBand
Lost time [s]	12.00

Phasing & Timing

Control Type	Permiss	Permiss	Permiss	Permiss	Permiss	Permiss	Protecte	Permiss	Permiss	Protecte	Permiss	Permiss
Signal group	0	2	0	0	6	0	3	8	0	7	4	0
Auxiliary Signal Groups												
Lead / Lag	-	-	-	-	-	-	Lead	-	-	Lead	-	-
Minimum Green [s]	0	5	0	0	5	0	5	5	0	5	5	0
Maximum Green [s]	0	30	0	0	30	0	30	30	0	30	30	0
Amber [s]	0.0	3.0	0.0	0.0	3.0	0.0	3.0	3.0	0.0	3.0	3.0	0.0
All red [s]	0.0	1.0	0.0	0.0	1.0	0.0	1.0	1.0	0.0	1.0	1.0	0.0
Split [s]	0	19	0	0	19	0	21	19	0	22	20	0
Vehicle Extension [s]	0.0	3.0	0.0	0.0	3.0	0.0	3.0	3.0	0.0	3.0	3.0	0.0
Walk [s]	0	5	0	0	5	0	0	5	0	0	5	0
Pedestrian Clearance [s]	0	10	0	0	10	0	0	10	0	0	10	0
Rest In Walk		No			No			No			No	
I1, Start-Up Lost Time [s]	0.0	2.0	0.0	0.0	2.0	0.0	2.0	2.0	0.0	2.0	2.0	0.0
I2, Clearance Lost Time [s]	0.0	2.0	0.0	0.0	2.0	0.0	2.0	2.0	0.0	2.0	2.0	0.0
Minimum Recall		No			No		No	No		No	No	
Maximum Recall		No			No		No	No		No	No	
Pedestrian Recall		No			No		No	No		No	No	
Detector Location [ft]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Detector Length [ft]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I, Upstream Filtering Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Exclusive Pedestrian Phase

Pedestrian Signal Group	0
Pedestrian Walk [s]	0
Pedestrian Clearance [s]	0

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Lane Group Calculations

Lane Group	C	R	C	R	L	C	R	L	C	R
C, Cycle Length [s]	60	60	60	60	60	60	60	60	60	60
L, Total Lost Time per Cycle [s]	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
l1_p, Permitted Start-Up Lost Time [s]	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
l2, Clearance Lost Time [s]	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
g_i, Effective Green Time [s]	15	15	15	15	2	27	27	6	32	32
g / C, Green / Cycle	0.25	0.25	0.25	0.25	0.03	0.45	0.45	0.10	0.53	0.53
(v / s)_i Volume / Saturation Flow Rate	0.27	0.08	0.08	0.03	0.01	0.19	0.01	0.08	0.19	0.00
s, saturation flow rate [veh/h]	135	1583	675	1583	1774	3547	1583	1774	3547	1583
c, Capacity [veh/h]	133	393	242	393	45	1601	715	178	1866	833
d1, Uniform Delay [s]	18.89	18.42	18.20	17.44	28.84	11.17	9.13	26.31	8.33	6.75
k, delay calibration	0.12	0.11	0.11	0.11	0.11	0.50	0.50	0.11	0.50	0.50
I, Upstream Filtering Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
d2, Incremental Delay [s]	1.23	0.47	0.45	0.12	7.80	0.83	0.07	6.82	0.55	0.01
d3, Initial Queue Delay [s]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rp, platoon ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
PF, progression factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Lane Group Results

X, volume / capacity	0.28	0.32	0.22	0.11	0.48	0.42	0.03	0.77	0.36	0.00
d, Delay for Lane Group [s/veh]	20.12	18.89	18.65	17.57	36.64	12.00	9.20	33.12	8.87	6.76
Lane Group LOS	C	B	B	B	D	B	A	C	A	A
Critical Lane Group	Yes	No	No	No	No	Yes	No	Yes	No	No
50th-Percentile Queue Length [veh]	0.40	1.34	0.54	0.44	0.37	2.35	0.11	1.97	1.77	0.02
50th-Percentile Queue Length [ft]	10.01	33.46	13.58	10.98	9.26	58.63	2.66	49.16	44.32	0.45
95th-Percentile Queue Length [veh]	0.72	2.41	0.98	0.79	0.67	4.22	0.19	3.54	3.19	0.03
95th-Percentile Queue Length [ft]	18.02	60.22	24.45	19.77	16.67	105.53	4.79	88.49	79.78	0.81

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Movement, Approach, & Intersection Results

d_M, Delay for Movement [s/veh]	20.12	20.12	18.89	18.65	18.65	17.57	36.64	12.00	9.20	33.12	8.87	6.76
Movement LOS	C	C	B	B	B	B	D	B	A	C	A	A
d_A, Approach Delay [s/veh]	19.17			18.16			12.68			12.92		
Approach LOS	B			B			B			B		
d_I, Intersection Delay [s/veh]	13.67											
Intersection LOS	B											
Intersection V/C	0.678											

Sequence

Ring 1	2	3	4	-	-	-	-	-	-	-	-	-	-	-	-	-
Ring 2	6	7	8	-	-	-	-	-	-	-	-	-	-	-	-	-
Ring 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ring 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Intersection Level Of Service Report
Intersection 1: State Route 12/Los Alamos Road

Control Type:	Signalized	Delay (sec / veh):	15.0
Analysis Method:	HCM 2010	Level Of Service:	B
Analysis Period:	15 minutes	Volume to Capacity (v/c):	0.471

Intersection Setup

Name	Los Alamos Rd			Los Alamos Rd			SR 12			SR 12		
Approach	Northbound			Southbound			Eastbound			Westbound		
Lane Configuration												
Turning Movement	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
Lane Width [ft]	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
No. of Lanes in Pocket	0	0	1	0	0	1	1	0	1	1	0	1
Pocket Length [ft]	100.00	100.00	125.00	100.00	100.00	125.00	325.00	100.00	160.00	285.00	100.00	200.00
Speed [mph]	35.00			35.00			55.00			55.00		
Grade [%]	0.00			0.00			0.00			0.00		
Crosswalk	Yes			Yes			Yes			No		

Volumes

Name	Los Alamos Rd			Los Alamos Rd			SR 12			SR 12		
Base Volume Input [veh/h]	37	41	147	5	19	45	37	778	28	170	940	16
Base Volume Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Heavy Vehicles Percentage [%]	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Growth Rate	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
In-Process Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Site-Generated Trips [veh/h]	3	0	0	0	0	0	0	0	3	0	0	0
Diverted Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Pass-by Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Existing Site Adjustment Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Other Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Right-Turn on Red Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Total Hourly Volume [veh/h]	40	41	147	5	19	45	37	778	31	170	940	16
Peak Hour Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Other Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Total 15-Minute Volume [veh/h]	10	10	37	1	5	11	9	195	8	43	235	4
Total Analysis Volume [veh/h]	40	41	147	5	19	45	37	778	31	170	940	16
Presence of On-Street Parking	No		No	No		No	No		No	No		No
On-Street Parking Maneuver Rate [/h]	0	0	0	0	0	0	0	0	0	0	0	0
Local Bus Stopping Rate [/h]	0	0	0	0	0	0	0	0	0	0	0	0
Pedestrian Volume [ped/h]	0			0			0			0		
Bicycle Volume [bicycles/h]	0			0			0			0		

Intersection Settings

Located in CBD	No
Signal Coordination Group	-
Cycle Length [s]	90
Coordination Type	Time of Day Pattern Isolated
Actuation Type	Fully actuated
Offset [s]	0.0
Offset Reference	LeadGreen
Permissive Mode	SingleBand
Lost time [s]	12.00

Phasing & Timing

Control Type	Permiss	Permiss	Permiss	Permiss	Permiss	Permiss	Protecte	Permiss	Permiss	Protecte	Permiss	Permiss
Signal group	0	2	0	0	6	0	3	8	0	7	4	0
Auxiliary Signal Groups												
Lead / Lag	-	-	-	-	-	-	Lead	-	-	Lead	-	-
Minimum Green [s]	0	5	0	0	5	0	5	5	0	5	5	0
Maximum Green [s]	0	30	0	0	30	0	30	30	0	30	30	0
Amber [s]	0.0	3.0	0.0	0.0	3.0	0.0	3.0	3.0	0.0	3.0	3.0	0.0
All red [s]	0.0	1.0	0.0	0.0	1.0	0.0	1.0	1.0	0.0	1.0	1.0	0.0
Split [s]	0	22	0	0	22	0	14	45	0	23	54	0
Vehicle Extension [s]	0.0	3.0	0.0	0.0	3.0	0.0	3.0	3.0	0.0	3.0	3.0	0.0
Walk [s]	0	5	0	0	5	0	0	5	0	0	5	0
Pedestrian Clearance [s]	0	10	0	0	10	0	0	10	0	0	10	0
Rest In Walk		No			No			No			No	
I1, Start-Up Lost Time [s]	0.0	2.0	0.0	0.0	2.0	0.0	2.0	2.0	0.0	2.0	2.0	0.0
I2, Clearance Lost Time [s]	0.0	2.0	0.0	0.0	2.0	0.0	2.0	2.0	0.0	2.0	2.0	0.0
Minimum Recall		No			No		No	No		No	No	
Maximum Recall		No			No		No	No		No	No	
Pedestrian Recall		No			No		No	No		No	No	
Detector Location [ft]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Detector Length [ft]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I, Upstream Filtering Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Exclusive Pedestrian Phase

Pedestrian Signal Group	0
Pedestrian Walk [s]	0
Pedestrian Clearance [s]	0

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Lane Group Calculations

Lane Group	C	R	C	R	L	C	R	L	C	R
C, Cycle Length [s]	90	90	90	90	90	90	90	90	90	90
L, Total Lost Time per Cycle [s]	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
l1_p, Permitted Start-Up Lost Time [s]	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
l2, Clearance Lost Time [s]	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
g_i, Effective Green Time [s]	10	10	10	10	3	57	57	11	64	64
g / C, Green / Cycle	0.12	0.12	0.12	0.12	0.03	0.63	0.63	0.12	0.72	0.72
(v / s)_i Volume / Saturation Flow Rate	0.07	0.09	0.01	0.03	0.02	0.22	0.02	0.10	0.27	0.01
s, saturation flow rate [veh/h]	1166	1583	1675	1583	1774	3547	1583	1774	3547	1583
c, Capacity [veh/h]	196	184	243	184	61	2243	1001	209	2538	1133
d1, Uniform Delay [s]	38.17	38.74	35.61	36.17	42.85	7.80	6.21	38.75	4.95	3.68
k, delay calibration	0.11	0.11	0.11	0.11	0.11	0.50	0.50	0.11	0.50	0.50
I, Upstream Filtering Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
d2, Incremental Delay [s]	1.40	7.64	0.17	0.68	9.13	0.43	0.06	7.42	0.42	0.02
d3, Initial Queue Delay [s]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rp, platoon ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
PF, progression factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Lane Group Results

X, volume / capacity	0.41	0.80	0.10	0.24	0.60	0.35	0.03	0.81	0.37	0.01
d, Delay for Lane Group [s/veh]	39.57	46.38	35.78	36.85	51.98	8.22	6.26	46.17	5.37	3.70
Lane Group LOS	D	D	D	D	D	A	A	D	A	A
Critical Lane Group	No	Yes	No	No	No	Yes	No	Yes	No	No
50th-Percentile Queue Length [veh]	1.76	3.47	0.47	0.91	0.92	2.71	0.18	3.82	2.11	0.06
50th-Percentile Queue Length [ft]	44.07	86.70	11.84	22.85	22.91	67.64	4.48	95.59	52.82	1.42
95th-Percentile Queue Length [veh]	3.17	6.24	0.85	1.65	1.65	4.87	0.32	6.88	3.80	0.10
95th-Percentile Queue Length [ft]	79.33	156.06	21.30	41.14	41.24	121.75	8.07	172.07	95.07	2.56

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Movement, Approach, & Intersection Results

d_M, Delay for Movement [s/veh]	39.57	39.57	46.38	35.78	35.78	36.85	51.98	8.22	6.26	46.17	5.37	3.70
Movement LOS	D	D	D	D	D	D	D	A	A	D	A	A
d_A, Approach Delay [s/veh]	43.96			36.48			10.06			11.51		
Approach LOS	D			D			B			B		
d_I, Intersection Delay [s/veh]	14.99											
Intersection LOS	B											
Intersection V/C	0.471											

Sequence

Ring 1	2	3	4	-	-	-	-	-	-	-	-	-	-	-	-	-
Ring 2	6	7	8	-	-	-	-	-	-	-	-	-	-	-	-	-
Ring 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ring 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Intersection Level Of Service Report
Intersection 1: State Route 12/Los Alamos Road

Control Type:	Signalized	Delay (sec / veh):	14.7
Analysis Method:	HCM 2010	Level Of Service:	B
Analysis Period:	15 minutes	Volume to Capacity (v/c):	1.054

Intersection Setup

Name	Los Alamos Rd			Los Alamos Rd			SR 12			SR 12		
Approach	Northbound			Southbound			Eastbound			Westbound		
Lane Configuration												
Turning Movement	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
Lane Width [ft]	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
No. of Lanes in Pocket	0	0	1	0	0	1	1	0	1	1	0	1
Pocket Length [ft]	100.00	100.00	125.00	100.00	100.00	125.00	325.00	100.00	160.00	285.00	100.00	200.00
Speed [mph]	35.00			35.00			55.00			55.00		
Grade [%]	0.00			0.00			0.00			0.00		
Crosswalk	Yes			Yes			Yes			No		

Volumes

Name	Los Alamos Rd			Los Alamos Rd			SR 12			SR 12		
Base Volume Input [veh/h]	34	13	126	13	48	50	24	703	55	184	863	4
Base Volume Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Heavy Vehicles Percentage [%]	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Growth Rate	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
In-Process Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Site-Generated Trips [veh/h]	2	0	0	0	0	0	0	0	3	0	0	0
Diverted Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Pass-by Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Existing Site Adjustment Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Other Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Right-Turn on Red Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Total Hourly Volume [veh/h]	36	13	126	13	48	50	24	703	58	184	863	4
Peak Hour Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Other Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Total 15-Minute Volume [veh/h]	9	3	32	3	12	13	6	176	15	46	216	1
Total Analysis Volume [veh/h]	36	13	126	13	48	50	24	703	58	184	863	4
Presence of On-Street Parking	No		No	No		No	No		No	No		No
On-Street Parking Maneuver Rate [/h]	0	0	0	0	0	0	0	0	0	0	0	0
Local Bus Stopping Rate [/h]	0	0	0	0	0	0	0	0	0	0	0	0
Pedestrian Volume [ped/h]	0			0			0			0		
Bicycle Volume [bicycles/h]	0			0			0			0		

Generated with PTV VISTRO
Version 5.00-00

Intersection Settings

Located in CBD	No
Signal Coordination Group	-
Cycle Length [s]	60
Coordination Type	Time of Day Pattern Isolated
Actuation Type	Fully actuated
Offset [s]	0.0
Offset Reference	LeadGreen
Permissive Mode	SingleBand
Lost time [s]	12.00

Phasing & Timing

Control Type	Permiss	Permiss	Permiss	Permiss	Permiss	Permiss	Protecte	Permiss	Permiss	Protecte	Permiss	Permiss
Signal group	0	2	0	0	6	0	3	8	0	7	4	0
Auxiliary Signal Groups												
Lead / Lag	-	-	-	-	-	-	Lead	-	-	Lead	-	-
Minimum Green [s]	0	5	0	0	5	0	5	5	0	5	5	0
Maximum Green [s]	0	30	0	0	30	0	30	30	0	30	30	0
Amber [s]	0.0	3.0	0.0	0.0	3.0	0.0	3.0	3.0	0.0	3.0	3.0	0.0
All red [s]	0.0	1.0	0.0	0.0	1.0	0.0	1.0	1.0	0.0	1.0	1.0	0.0
Split [s]	0	19	0	0	19	0	21	19	0	22	20	0
Vehicle Extension [s]	0.0	3.0	0.0	0.0	3.0	0.0	3.0	3.0	0.0	3.0	3.0	0.0
Walk [s]	0	5	0	0	5	0	0	5	0	0	5	0
Pedestrian Clearance [s]	0	10	0	0	10	0	0	10	0	0	10	0
Rest In Walk		No			No			No			No	
I1, Start-Up Lost Time [s]	0.0	2.0	0.0	0.0	2.0	0.0	2.0	2.0	0.0	2.0	2.0	0.0
I2, Clearance Lost Time [s]	0.0	2.0	0.0	0.0	2.0	0.0	2.0	2.0	0.0	2.0	2.0	0.0
Minimum Recall		No			No		No	No		No	No	
Maximum Recall		No			No		No	No		No	No	
Pedestrian Recall		No			No		No	No		No	No	
Detector Location [ft]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Detector Length [ft]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I, Upstream Filtering Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Exclusive Pedestrian Phase

Pedestrian Signal Group	0
Pedestrian Walk [s]	0
Pedestrian Clearance [s]	0

Lane Group Calculations

Lane Group	C	R	C	R	L	C	R	L	C	R
C, Cycle Length [s]	60	60	60	60	60	60	60	60	60	60
L, Total Lost Time per Cycle [s]	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
l1_p, Permitted Start-Up Lost Time [s]	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
l2, Clearance Lost Time [s]	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
g_i, Effective Green Time [s]	15	15	15	15	2	25	25	8	31	31
g / C, Green / Cycle	0.25	0.25	0.25	0.25	0.03	0.42	0.42	0.13	0.52	0.52
(v / s)_i Volume / Saturation Flow Rate	0.54	0.08	0.08	0.03	0.01	0.20	0.04	0.10	0.24	0.00
s, saturation flow rate [veh/h]	91	1583	770	1583	1774	3547	1583	1774	3547	1583
c, Capacity [veh/h]	127	392	263	392	49	1491	666	234	1861	831
d1, Uniform Delay [s]	23.36	18.44	18.19	17.53	28.76	12.57	10.46	25.23	8.95	6.79
k, delay calibration	0.50	0.11	0.11	0.11	0.11	0.50	0.50	0.11	0.50	0.50
I, Upstream Filtering Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
d2, Incremental Delay [s]	8.72	0.47	0.44	0.14	7.49	1.07	0.26	5.79	0.83	0.01
d3, Initial Queue Delay [s]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rp, platoon ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
PF, progression factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Lane Group Results

X, volume / capacity	0.39	0.32	0.23	0.13	0.49	0.47	0.09	0.79	0.46	0.00
d, Delay for Lane Group [s/veh]	32.08	18.91	18.63	17.67	36.26	13.64	10.72	31.01	9.79	6.80
Lane Group LOS	C	B	B	B	D	B	B	C	A	A
Critical Lane Group	Yes	No	No	No	No	Yes	No	Yes	No	No
50th-Percentile Queue Length [veh]	0.97	1.34	0.63	0.50	0.40	2.70	0.39	2.52	2.45	0.02
50th-Percentile Queue Length [ft]	24.27	33.47	15.65	12.54	9.95	67.55	9.71	63.03	61.25	0.45
95th-Percentile Queue Length [veh]	1.75	2.41	1.13	0.90	0.72	4.86	0.70	4.54	4.41	0.03
95th-Percentile Queue Length [ft]	43.68	60.25	28.16	22.57	17.91	121.59	17.47	113.45	110.25	0.82

Movement, Approach, & Intersection Results

d_M, Delay for Movement [s/veh]	32.08	32.08	18.91	18.63	18.63	17.67	36.26	13.64	10.72	31.01	9.79	6.80
Movement LOS	C	C	B	B	B	B	D	B	B	C	A	A
d_A, Approach Delay [s/veh]	22.60			18.20			14.12			13.49		
Approach LOS	C			B			B			B		
d_I, Intersection Delay [s/veh]	14.72											
Intersection LOS	B											
Intersection V/C	1.054											

Sequence

Ring 1	2	3	4	-	-	-	-	-	-	-	-	-	-	-	-	-
Ring 2	6	7	8	-	-	-	-	-	-	-	-	-	-	-	-	-
Ring 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ring 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Intersection Level Of Service Report
Intersection 1: State Route 12/Los Alamos Road

Control Type:	Signalized	Delay (sec / veh):	16.0
Analysis Method:	HCM 2010	Level Of Service:	B
Analysis Period:	15 minutes	Volume to Capacity (v/c):	0.539

Intersection Setup

Name	Los Alamos Rd			Los Alamos Rd			SR 12			SR 12		
Approach	Northbound			Southbound			Eastbound			Westbound		
Lane Configuration												
Turning Movement	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
Lane Width [ft]	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
No. of Lanes in Pocket	0	0	1	0	0	1	1	0	1	1	0	1
Pocket Length [ft]	100.00	100.00	125.00	100.00	100.00	125.00	325.00	100.00	160.00	285.00	100.00	200.00
Speed [mph]	35.00			35.00			55.00			55.00		
Grade [%]	0.00			0.00			0.00			0.00		
Crosswalk	Yes			Yes			Yes			No		

Volumes

Name	Los Alamos Rd			Los Alamos Rd			SR 12			SR 12		
Base Volume Input [veh/h]	39	46	165	5	23	48	42	895	34	196	958	17
Base Volume Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Heavy Vehicles Percentage [%]	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Growth Rate	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
In-Process Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Site-Generated Trips [veh/h]	3	0	0	0	0	0	0	0	3	0	0	0
Diverted Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Pass-by Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Existing Site Adjustment Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Other Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Right-Turn on Red Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Total Hourly Volume [veh/h]	42	46	165	5	23	48	42	895	37	196	958	17
Peak Hour Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Other Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Total 15-Minute Volume [veh/h]	11	12	41	1	6	12	11	224	9	49	240	4
Total Analysis Volume [veh/h]	42	46	165	5	23	48	42	895	37	196	958	17
Presence of On-Street Parking	No		No	No		No	No		No	No		No
On-Street Parking Maneuver Rate [/h]	0	0	0	0	0	0	0	0	0	0	0	0
Local Bus Stopping Rate [/h]	0	0	0	0	0	0	0	0	0	0	0	0
Pedestrian Volume [ped/h]	0			0			0			0		
Bicycle Volume [bicycles/h]	0			0			0			0		

Intersection Settings

Located in CBD	No
Signal Coordination Group	-
Cycle Length [s]	90
Coordination Type	Time of Day Pattern Isolated
Actuation Type	Fully actuated
Offset [s]	0.0
Offset Reference	LeadGreen
Permissive Mode	SingleBand
Lost time [s]	12.00

Phasing & Timing

Control Type	Permiss	Permiss	Permiss	Permiss	Permiss	Permiss	Protecte	Permiss	Permiss	Protecte	Permiss	Permiss
Signal group	0	2	0	0	6	0	3	8	0	7	4	0
Auxiliary Signal Groups												
Lead / Lag	-	-	-	-	-	-	Lead	-	-	Lead	-	-
Minimum Green [s]	0	5	0	0	5	0	5	5	0	5	5	0
Maximum Green [s]	0	30	0	0	30	0	30	30	0	30	30	0
Amber [s]	0.0	3.0	0.0	0.0	3.0	0.0	3.0	3.0	0.0	3.0	3.0	0.0
All red [s]	0.0	1.0	0.0	0.0	1.0	0.0	1.0	1.0	0.0	1.0	1.0	0.0
Split [s]	0	22	0	0	22	0	14	45	0	23	54	0
Vehicle Extension [s]	0.0	3.0	0.0	0.0	3.0	0.0	3.0	3.0	0.0	3.0	3.0	0.0
Walk [s]	0	5	0	0	5	0	0	5	0	0	5	0
Pedestrian Clearance [s]	0	10	0	0	10	0	0	10	0	0	10	0
Rest In Walk		No			No			No			No	
I1, Start-Up Lost Time [s]	0.0	2.0	0.0	0.0	2.0	0.0	2.0	2.0	0.0	2.0	2.0	0.0
I2, Clearance Lost Time [s]	0.0	2.0	0.0	0.0	2.0	0.0	2.0	2.0	0.0	2.0	2.0	0.0
Minimum Recall		No			No		No	No		No	No	
Maximum Recall		No			No		No	No		No	No	
Pedestrian Recall		No			No		No	No		No	No	
Detector Location [ft]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Detector Length [ft]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I, Upstream Filtering Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Exclusive Pedestrian Phase

Pedestrian Signal Group	0
Pedestrian Walk [s]	0
Pedestrian Clearance [s]	0

Lane Group Calculations

Lane Group	C	R	C	R	L	C	R	L	C	R
C, Cycle Length [s]	90	90	90	90	90	90	90	90	90	90
L, Total Lost Time per Cycle [s]	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
l1_p, Permitted Start-Up Lost Time [s]	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
l2, Clearance Lost Time [s]	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
g_i, Effective Green Time [s]	11	11	11	11	3	55	55	12	63	63
g / C, Green / Cycle	0.13	0.13	0.13	0.13	0.04	0.61	0.61	0.13	0.70	0.70
(v / s)_i Volume / Saturation Flow Rate	0.06	0.10	0.02	0.03	0.02	0.25	0.02	0.11	0.27	0.01
s, saturation flow rate [veh/h]	1531	1583	1763	1583	1774	3547	1583	1774	3547	1583
c, Capacity [veh/h]	255	202	273	202	66	2148	959	236	2489	1111
d1, Uniform Delay [s]	36.36	38.23	34.77	35.32	42.75	9.36	7.17	38.04	5.49	4.05
k, delay calibration	0.11	0.11	0.11	0.11	0.11	0.50	0.50	0.11	0.50	0.50
I, Upstream Filtering Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
d2, Incremental Delay [s]	0.80	7.74	0.16	0.60	9.75	0.60	0.08	7.34	0.45	0.03
d3, Initial Queue Delay [s]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rp, platoon ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
PF, progression factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Lane Group Results

X, volume / capacity	0.35	0.81	0.10	0.24	0.64	0.42	0.04	0.83	0.38	0.02
d, Delay for Lane Group [s/veh]	37.16	45.97	34.93	35.91	52.50	9.96	7.24	45.38	5.94	4.08
Lane Group LOS	D	D	C	D	D	A	A	D	A	A
Critical Lane Group	No	Yes	No	No	No	Yes	No	Yes	No	No
50th-Percentile Queue Length [veh]	1.81	3.88	0.54	0.96	1.04	3.67	0.24	4.37	2.40	0.07
50th-Percentile Queue Length [ft]	45.28	97.02	13.60	23.99	26.05	91.63	6.02	109.33	60.01	1.66
95th-Percentile Queue Length [veh]	3.26	6.99	0.98	1.73	1.88	6.60	0.43	7.80	4.32	0.12
95th-Percentile Queue Length [ft]	81.51	174.64	24.48	43.17	46.89	164.94	10.84	195.07	108.02	2.99

Movement, Approach, & Intersection Results

d_M, Delay for Movement [s/veh]	37.16	37.16	45.97	34.93	34.93	35.91	52.50	9.96	7.24	45.38	5.94	4.08
Movement LOS	D	D	D	C	C	D	D	A	A	D	A	A
d_A, Approach Delay [s/veh]	42.91			35.55			11.69			12.52		
Approach LOS	D			D			B			B		
d_I, Intersection Delay [s/veh]	16.00											
Intersection LOS	B											
Intersection V/C	0.539											

Sequence

Ring 1	2	3	4	-	-	-	-	-	-	-	-	-	-	-	-	-
Ring 2	6	7	8	-	-	-	-	-	-	-	-	-	-	-	-	-
Ring 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ring 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-