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<td>CLIENT</td>
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<td>PROJECT NUMBER</td>
<td>522-9-1</td>
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Type of Services: Geotechnical Investigation

Project Name: Tennant Avenue Sanitary Sewer Improvements

Location: Tennant Avenue
Morgan Hill, California

Client: Mott MacDonald

Client Address: 2077 Gateway Place, Suite 550
San Jose, CA 95110

Project Number: 522-9-1

Date: July 9, 2018

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Geotechnical Project Manager

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Quality Assurance Reviewer
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FIGURE 1: VICINITY MAP
FIGURE 2: SITE PLAN
FIGURE 3: REGIONAL FAULT MAP

APPENDIX A: FIELD INVESTIGATION
APPENDIX B: LABORATORY TEST PROGRAM
SECTION 1: INTRODUCTION

This geotechnical report was prepared for the sole use of Mott MacDonald for the Tennant Avenue Sanitary Sewer Improvement project in Morgan Hill, California. The location of the site is shown on the Vicinity Map, Figure 1. For our use, we were provided with the following documents:

- A site plan titled “Exhibit E – Block Map for Tennant Avenue Sewer Mains Project” showing the existing utilities, provided by the City of Morgan Hill, un-dated.

1.1 PROJECT DESCRIPTION

We understand that sewer improvements will occur along Tennant Avenue between Monterey Road and to about 130 northeast of Railroad Avenue. The proposed improvements will consist of replacing about 1,900 linear feet of existing 8-inch diameter VCP sanitary sewer pipe with 24-inch diameter PVC pipe using an open-cut trenching method, construction of about 370 linear feet of 24-inch diameter PVC using an open-cut trenching method, construction of about 140 linear feet of 24-inch diameter PVC using a trenchless method (i.e., auger boring or pipe ramming methods) next to the Railroad Avenue intersection (UPRR tracks area), and construction of possible new manholes along the proposed pipe alignment. The invert of the new sanitary sewer pipe will range from about 12 to 16 feet below the existing surface grades.

1.2 SCOPE OF SERVICES

Our scope of services was presented in our proposal dated September 26, 2017 and consisted of field and laboratory programs to evaluate physical and engineering properties of the subsurface soils, engineering analysis to prepare information for the proposed pipe design and construction, and preparation of this report. Brief descriptions of our exploration and laboratory programs are presented below.
1.3 EXPLORATION PROGRAM

Field exploration consisted of two borings drilled on March 29, 2018 by Exploration Geoservices, Inc. with a truck-mounted, Mobile B-61 drill rig, with 8-inch-diameter hollow-stem auger drilling equipment. The borings were drilled to a depth of 20 feet. The borings were backfilled with cement/sand slurry delivered directly from a ready-mix plant in accordance with the City of Morgan Hill requirements.

The approximate locations of our exploratory borings are shown on the Site Plan, Figure 2. Details regarding our field program are included in Appendix A.

1.4 LABORATORY TESTING PROGRAM

In addition to visual classification of samples, the laboratory program focused on obtaining data for further classification of soil types and characteristics. Testing included moisture contents, dry densities, and a Plasticity Index test. Details regarding our laboratory program are included in Appendix B.

1.5 ENVIRONMENTAL SERVICES

Environmental services were not requested for this project. If environmental concerns are determined to be present during future evaluations, the project environmental consultant should review our geotechnical recommendations for compatibility with the environmental concerns.

SECTION 2: REGIONAL SETTING

2.1 REGIONAL AND LOCAL GEOLOGY

The site is located within southern end of the Santa Clara Valley, which is a broad alluvial plane between the Santa Cruz Mountains to the southwest and west, and the Diablo Range to the northeast. The San Andreas Fault system, including the Monte Vista-Shannon Fault, exists within the Santa Cruz Mountains and the Hayward and Calaveras Fault systems exist within the Diablo Range. Alluvial soil thicknesses in the area of Morgan Hill range up to about 300 feet (Rogers & Williams, 1974).

2.2 REGIONAL SEISMICITY

The San Francisco Bay area region is one of the most seismically active areas in the Country. While seismologists cannot predict earthquake events, geologists from the U.S. Geological Survey have recently updated earlier estimates from their 2014 Uniform California Earthquake Rupture Forecast (Version 3) publication. The estimated probability of one or more magnitude 6.7 earthquakes (the size of the destructive 1994 Northridge earthquake) expected to occur somewhere in the San Francisco Bay Area has been revised (increased) to 72 percent for the period 2014 to 2043 (Aagaard et al., 2016). The faults in the region with the highest estimated probability of generating damaging earthquakes between 2014 and 2043 are the Hayward (33%), Rodgers Creek (33%), Calaveras (26%), and San Andreas Faults (22%). In this 30-year
period, the probability of an earthquake of magnitude 6.7 or larger occurring is 22 percent along
the San Andreas Fault and 33 percent for the Hayward or Rodgers Creek Faults. During such
an earthquake the danger of fault surface rupture at the site is slight, but very strong to severe
ground shaking would occur. The site is not located within 2 kilometers of an active or
potentially active fault and therefore near source factors will not apply in the seismic design of
structures at the site.

The faults considered capable of generating significant earthquakes are generally associated
with the well-defined areas of crustal movement, which trend northwesterly. The table below
presents the State-considered active faults within 25 kilometers of the site. It is noted that the
fault distances presented in Table 1 were determined from EZ Frisk and represent the rupture
distance and may not be the distance to the surface expression of the fault that is shown on
published geological maps and on-line resources such as Google Earth, etc.

Table 1: Approximate Fault Distances

<table>
<thead>
<tr>
<th>Fault Name</th>
<th>Distance (miles)</th>
<th>Distance (kilometers)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calaveras</td>
<td>4.7</td>
<td>6.6</td>
</tr>
<tr>
<td>Sargent</td>
<td>8.0</td>
<td>11.2</td>
</tr>
<tr>
<td>San Andreas (1906)</td>
<td>11.5</td>
<td>16.0</td>
</tr>
<tr>
<td>Hayward (Southeast Extension)</td>
<td>6.3</td>
<td>18.8</td>
</tr>
<tr>
<td>Monte Vista-Shannon</td>
<td>14.5</td>
<td>20.3</td>
</tr>
<tr>
<td>Zayante-Vergeles</td>
<td>15.2</td>
<td>21.3</td>
</tr>
</tbody>
</table>

A regional fault map is presented as Figure 3, illustrating the relative distances of the site to
significant fault zones.

SECTION 3: SITE CONDITIONS

3.1 SURFACE DESCRIPTION

As stated earlier, our field investigation consisted of advancing two exploratory borings at
various locations that were closely offset from the existing sewer line alignment. Existing
pavement sections consisted of about 8 inches of asphalt concrete over about 3 to 4 inches of
aggregate base. The pavements generally appear in good to fair condition with minor
longitudinal or transverse cracking at various locations.

3.2 SUBSURFACE CONDITIONS

3.2.1 Railroad Avenue Area (EB-1)

Below the surface pavements, silty sand with gravel was encountered to a depth of about 3 feet,
which was underlain by very dense to dense clayey sand with fine to coarse sub-angular to sub-
rounded gravel and possible sandstone cobble fragments to a depth of about 14 feet. Below these surficial soils we encountered stiff lean clay with sand and some fine to sub-angular to rounded gravel to a depth of about 17 feet, which was underlain by very dense, poorly graded, fine to coarse sub-angular to rounded gravel with clay and sand to the termination depth of 20 feet below the existing surface grades.

3.2.2 Monterey Road Area (EB-2)

Below the surface pavements, sandy lean clay with gravel was encountered to a depth of about 2 feet and underlain by hard, moderately plastic lean clay with sand to the termination depth of 20 feet below the existing surface grades. We encountered a thin interbedded very dense sub-rounded sandstone/shale gravel at a depth of about 14 feet below the existing surface grades.

3.2.3 Plasticity/Expansion Potential

We performed one Plasticity Index (PI) test on a representative sample at a depth of about 9 feet below the existing grade in Boring EB-2. The test result was used to evaluate the expansion potential of the soil. The PI test resulted in a PI of 18, indicating moderate expansion potential to wetting and drying cycles.

3.2.4 In-Situ Moisture Contents

Laboratory testing indicated that the in-situ moisture contents within the upper 20 feet range from 4 percent under to 10 percent over the estimated laboratory optimum moisture.

3.3 GROUND WATER

Ground water was not encountered in any of our borings during drilling to a maximum depth of 20 feet; however, the borings were not left open but were immediately backfilled when the boring was completed.

Ground water levels are not currently mapped in the area; however, based on our experience within the area, we anticipate ground water to be below the existing and proposed sanitary sewer lines, although perched ground water may be encountered at portions of the site.

Fluctuations in ground water levels occur due to many factors including seasonal fluctuation, underground drainage patterns, regional fluctuations, and other factors.

SECTION 4: MANHOLE FOUNDATION SUPPORT

We understand that construction of new manholes is also currently planned for this project along the proposed sanitary sewer alignment to depths ranging from 12 to 16 feet below the existing surface grades. Manhole foundations bearing on undisturbed natural soils are capable of supporting maximum static bearing pressures of 3,000 psf near all boring locations. If wet or unstable conditions are encountered, it may be desirable to place 12 to 18 inches of crushed rock at the bottom of manhole excavations to stabilize and provide a better working surface.
SECTION 5: OPEN-CUT TRENCHING METHOD

Excavations for open-cut trenching sections will be made adjacent to existing utilities and within City streets or easement areas; therefore, the trenching will require temporary support in order to avoid damaging the adjacent streets, utilities, and other improvements. Excavation should be readily accomplished with standard backhoes and excavators during or after shoring installations.

The Contractor should be responsible for all temporary slopes and design of any required shoring. Shoring, bracing or temporary slopes should be performed by the Contractor in accordance with the strictest governing safety standards.

Based on the site conditions encountered during our investigation, the cuts may be supported by braced excavations, sheet piles, deep soil mixing, or potentially other methods, depending on the judgment of the shoring designer and Contractor. We do not recommend the use of trench boxes/shields or improvised shoring systems consisting of hydraulic speed shores, steel plates, trench boxes/shields or combinations, thereof. As discussed in Section 3.2, layers of very dense sand with gravel and hard clay with possible sandstone cobbles were encountered within our boring and may impact the driving of sheet piles. Installation of sheet piles with auger assistance may be used if approved by the Engineer. Where shoring will extend more than about 10 feet, restrained shoring will most likely be required to limit detrimental lateral deflections and settlement behind the shoring. In addition to soil earth pressures, the shoring system will need to support adjacent loads such as construction vehicles and incidental loading, existing structure foundation loads, and street loading. We recommend that heavy construction loads (e.g., dump trucks, water trucks, etc.) and material stockpiles be kept at least 15 feet behind the shoring. Where this loading cannot be set back, the shoring will need to be designed to support the loading. The shoring designer should provide for timely and uniform mobilization of soil pressures that will not result in excessive lateral deflections. Minimum suggested geotechnical parameters for shoring design are provided in the table below.

Table 2: Suggested Temporary Shoring Design Parameters

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Value</th>
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<tbody>
<tr>
<td>Minimum Lateral Wall Surcharge (upper 5 feet)</td>
<td>120 psf</td>
</tr>
<tr>
<td>Cantilever Wall – Triangular Earth Pressure</td>
<td>40 pcf</td>
</tr>
<tr>
<td>Restrained Wall – Trapezoidal Earth Pressure - Clayey Soil</td>
<td>Increase from 0 to 25H^{1.3} psf</td>
</tr>
<tr>
<td>Restrained Wall – Uniform Earth Pressure - Granular Soil</td>
<td>25H^{2.3}</td>
</tr>
<tr>
<td>Passive Pressure – Starting at 1 foot below the bottom of the excavation</td>
<td>375 pcf up to 2,000 psf maximum uniform pressure</td>
</tr>
</tbody>
</table>

1 H equals the height of the excavation. Hinge points at \( \frac{1}{4}H \) and \( \frac{3}{4}H \).
2 H equals the height of the excavation. Uniform earth pressure.
3 The above pressures do not consider hydrostatic pressure due to ground water.

We performed our borings with hollow-stem auger drilling equipment and as such were not able to evaluate the potential for caving soils, which can create difficult conditions during soldier
beam installation; caving soils can also be problematic during excavations. The contractor is responsible for evaluating excavation difficulties prior to construction. Where relatively clean sands (especially encountered below ground water) or difficult drilling or cobble conditions were encountered during our exploration, pilot explorations performed by the contractor may be desired to further evaluate these conditions prior to the finalization of the shoring budget.

In addition to anticipated deflection of the shoring system, other factors such as voids created by soil sloughing, and erosion of granular layers due to perched water conditions can create adverse ground subsidence and deflections. The contractor should attempt to cut the excavation as close to neat lines as possible; where voids are created they should be backfilled as soon as possible with sand, gravel, or grout.

As previously mentioned, we recommend that a monitoring program be developed and implemented to evaluate the effects of the shoring on adjacent improvements. All sensitive improvements should be located and monitored for horizontal and vertical deflections and distress cracking based on a pre-construction survey. The monitoring frequency should be established and agreed to by the project team prior to start of shoring construction.

The above recommendations are for the use of the design team; the contractor in conjunction with input from the shoring designer should perform additional subsurface exploration they deem necessary to design the chosen shoring system. A California-licensed civil or structural engineer must design and be in responsible charge of the temporary shoring design. The contractor is responsible for means and methods of construction, as well as site safety.

SECTION 6: TRENCHLESS METHOD

There are several trenchless tunneling techniques that could be used to install the proposed sewer pipe in the undercrossing of Railroad Avenue and the UPRR right-of-way. It is our understanding that auger boring or pipe ramming methods are being considered to install the new sanitary sewer pipe undercrossing. Based on our understanding of the location of the undercrossing, the length, the subsurface conditions, and the approximate invert depths, we expect that these methods may be feasible. A trenchless installation consultant/contractor should be retained to select the means and methods for trenchless pipe installation based on the subsurface conditions disclosed by our site investigation.

6.1 JACKING AND RECEIVING PITS

Vertical excavations on the order of 15 to 20 feet are anticipated to construct the entry and exit pits. These excavations will be made adjacent to existing utilities and city streets and, therefore, will require temporary support in order to avoid damaging the adjacent streets, sidewalks, utilities, and other improvements. We anticipate that a majority of the excavation will encounter very dense granular soils and possibly cobbles. Excavation of the pits should be readily accomplished with standard backhoes and excavators during or after shoring installations.

The Contractor should be responsible for all temporary slopes and design of any required shoring. The design of the shoring at entry and exit pits, as well as design of the jacking system,
should be performed by a Registered Civil or Structural Engineer, retained by the Contractor, and submitted to the Engineer prior to its implementation. Shoring, bracing or temporary slopes should be performed by the Contractor in accordance with the strictest governing safety standards.

Vertical excavations may be temporarily shored using sheet piling, soldier piles and lagging, braced shoring or other shoring schemes, depending on the judgment of the shoring designer and Contractor. As discussed in Section 3.2.1, layers of very dense sand with fine to coarse sub-angular to sub-rounded gravel and possible cobbles and very dense poorly graded fine to coarse sub-angular to rounded gravel with clay and sand were encountered within our boring and may impact the driving of sheet piles or other installation methods. Installation of sheet piles with auger assistance may be used if approved by the Engineer.

Recommended design parameters for construction of a temporary shoring system for jacking and receiving pits are provided in Section 5 of this report.

SECTION 7: POTENTIAL GEOTECHNICAL IMPACTS

7.1 POTENTIAL CONCERNS

From a geotechnical viewpoint, the Tennant Avenue Sewer Improvements appear feasible provided the concerns listed below are addressed in the project design. Descriptions of each concern with brief outlines of our recommendations follow the listed concerns.

7.1.1 Residential Construction Areas

The project site is located within an area of residential development where there will be concerns about construction noise and vibrations. For these reasons, our judgement is that installing either steel piles or sheet piles using impact equipment has substantial risk of being a nuisance, and that braced sheeting or similar methods may be preferred.

7.1.2 Presence of Very Dense Deposits

As previously discussed in the subsurface conditions section of this report, Section 3.2.1, we encountered very dense sand with fine to coarse sub-angular to sub-rounded gravel and cobbles, and very-dense, poorly-graded, fine to coarse sub-angular to rounded gravel with clay and sand. Trenchless and shoring contractors should review the subsurface conditions in our boring logs prior to bidding and selecting installation/drilling equipment and methods. The potential for ground loss and ground behavior during installation should be evaluated by the consultants.

7.1.3 Ground Displacement and Cracking

The planned sewer pipe construction/replacement methods have the potential risk of causing ground displacements that may damage existing utilities.
For open-cut trenching, the shoring design and construction sequencing can address these potential risks.

We understand that a trenchless method may be considered for undercrossing of Railroad Avenue and the UPRR right-of-way. This method of sewer pipe construction has the potential risk of causing ground displacements that may damage existing utilities or structures. These potential risks can be addressed by the depth of cover over the horizontal alignment and by paying close attention to and monitoring the horizontal drilling pressures and the potential for ground loss; however, even with these precautions, some risks of ground displacement, settling or cracking remain.

7.1.4 Deflection of the Entry/Exit Pit Shoring System

Existing utilities, pavements and other improvements will likely be in close proximity to the pits excavated to advance the casing in the undercrossing. Shoring systems should be designed with sufficient rigidity to limit detrimental deflections that result in movement of critical improvements. Good construction techniques should also be used to install and apply restraint, if necessary, in a timely manner. In no case should deflections exceed 1 inch.

7.1.5 Presence of Existing Utilities

We anticipate existing utilities will be present near the planned construction areas specifically at both ends of the site. An appropriate amount of clearance is desirable to reduce the risk of damaging the existing utilities when installing the new sewer improvements.

7.1.6 Perched Ground Water

Ground water levels are not mapped in the area and were not encountered in any of our borings; however, perched ground water may be encountered within the layered granular soils seasonally.

SECTION 8: GENERAL EARTHWORK

The earthwork anticipated for this project is likely to consist of excavations for lateral and cleanout replacements and lateral connections to main lines, clearing the open cuts and entry/exit pit areas of surface pavements, excavating the open cuts and entry/receiving pits, installation and removal of temporary shoring systems, backfilling of the open cuts and entry/receiving pits, and restoration of the surface pavement improvements. These are discussed in the following sections.

8.1 CLEARING AND SPOIL DISPOSAL

In the designated areas of the open cuts, the site should be cleared of all surface and subsurface deleterious materials designated for removal, including existing pavements, curb and gutter, buried utility lines, debris, designated trees, shrubs, and associated roots. All
deleterious materials should be removed from the site and properly disposed of in accordance with regulatory requirements.

8.2 MATERIAL FOR FILL

All on-site soils having an organic content of less than 3 percent by weight appear suitable for re-use as fill at the site. In general, fill material should not contain rocks or lumps larger than 6 inches in greatest dimension, with no more than 15 percent larger than 2½ inches. Imported fill material should be predominantly granular with a Plasticity Index of 15 or less. To prevent significant caving during future trenching or excavations, imported material should have sufficient fines. Samples of potential import sources should be delivered to our office at least 10 days prior to the desired import start date. Information regarding the import source should be provided, such as any site geotechnical and environmental reports.

Environmental and soil corrosion characterization should also be considered by the project team prior to acceptance. Suitable environmental laboratory data for the planned import quantity should be provided to the project environmental consultant; additional laboratory testing may be required based on the project environmental consultant’s review. The potential import source should also not be more corrosive than the on-site soils, based on pH, saturated resistivity, soluble sulfate, chloride, sulfates, and redox potential.

8.3 BACKFILL COMPACTATION

All backfill should be compacted in accordance with the City of Morgan Hill requirements or the recommendations contained in this section, whichever is more stringent. Fill materials should be placed in lifts not exceeding 8 inches in uncompacted thickness and should be compacted to at least 90 percent relative compaction for low plasticity soils and between 87 to 92 percent relative compaction for moderate to high plasticity soils in the upper 5 feet (ASTM D1557, latest edition) by mechanical means only. The aggregate base and pavement sections should be restored to their original thicknesses and grades or as required by the City of Morgan Hill. The upper 6 inches of subgrade in pavement areas and all aggregate base and asphalt concrete should be compacted to at least 95 percent relative compaction (ASTM D1557, latest edition). Aggregate base and all import soils should be compacted at a moisture content near the laboratory optimum.

8.4 PLANS AND SPECIFICATIONS REVIEW

We recommend that we be retained to review the geotechnical aspects of the project plans and specifications, allowing sufficient time to provide the design team with any comments prior to issuing the plans for construction.

8.5 CONSTRUCTION OBSERVATION

As site conditions may vary significantly between the small-diameter borings performed during this investigation, we also recommend that a Cornerstone representative be present to provide geotechnical observation and testing during earthwork and related construction activities. This
will allow us to form an opinion and prepare a letter at the end of construction regarding contractor compliance with project plans and specifications, and with the recommendations in our report. We would also be allowed to evaluate any conditions differing from those encountered during our investigation, and provide supplemental recommendations as necessary. Contractors should provide at least a 48-hour notice when scheduling our field personnel.

**SECTION 9: LIMITATIONS**

This report, an instrument of professional service, has been prepared for the sole use of Mott MacDonald specifically to support the design of the Tennant Avenue Sanitary Sewer Improvements in Morgan Hill, California. The opinions, conclusions, and recommendations presented in this report have been formulated in accordance with accepted geotechnical engineering practices that exist in Northern California at the time this report was prepared. No warranty, expressed or implied, is made or should be inferred.

Recommendations in this report are based upon the soil and ground water conditions encountered during our subsurface exploration. If variations or unsuitable conditions are encountered during construction, Cornerstone must be contacted to provide supplemental recommendations, as needed.

Mott MacDonald may have provided Cornerstone with plans, reports and other documents prepared by others. Mott MacDonald understands that Cornerstone reviewed and relied on the information presented in these documents and cannot be responsible for their accuracy.

Cornerstone prepared this report with the understanding that it is the responsibility of the owner or his representatives to see that the recommendations contained in this report are presented to other members of the design team and incorporated into the project plans and specifications, and that appropriate actions are taken to implement the geotechnical recommendations during construction.

Conclusions and recommendations presented in this report are valid as of the present time for the development as currently planned. Changes in the condition of the property or adjacent properties may occur with the passage of time, whether by natural processes or the acts of other persons. In addition, changes in applicable or appropriate standards may occur through legislation or the broadening of knowledge. Therefore, the conclusions and recommendations presented in this report may be invalidated, wholly or in part, by changes beyond Cornerstone’s control. This report should be reviewed by Cornerstone after a period of three (3) years has elapsed from the date of this report. In addition, if the current project design is changed, then Cornerstone must review the proposed changes and provide supplemental recommendations, as needed.

An electronic transmission of this report may also have been issued. While Cornerstone has taken precautions to produce a complete and secure electronic transmission, please check the electronic transmission against the hard copy version for conformity.
Recommendations provided in this report are based on the assumption that Cornerstone will be retained to provide observation and testing services during construction to confirm that conditions are similar to that assumed for design, and to form an opinion as to whether the work has been performed in accordance with the project plans and specifications. If we are not retained for these services, Cornerstone cannot assume any responsibility for any potential claims that may arise during or after construction as a result of misuse or misinterpretation of Cornerstone’s report by others. Furthermore, Cornerstone will cease to be the Geotechnical-Engineer-of-Record if we are not retained for these services.

SECTION 10: REFERENCES


Vicinity Map

Tennant Avenue
Sanitary Sewer Improvement
Morgan Hill, CA
Legend

Approximate location of exploratory boring (EB)
Regional Fault Map

Tennant Avenue Sanitary Sewer Improvement
Morgan Hill, CA

June 2018

1. Undivided Quaternary faults - most faults in this category show evidence of displacement during the last 1,600,000 years; possible exceptions are faults which displace rocks of undifferentiated Pliocene-Pleistocene age.

2. Fault cuts strata of Quaternary age.

3. Faults without recognized Quaternary displacement or showing evidence of no displacement during Quaternary time. Not necessarily inactive.

4. Fault cuts strata of Pliocene or older age.

5. Fault offset seaward sediments to mid-Holocene age.

6. Fault offset seaward sediments to early Holocene age.

7. Fault offset seafloor sediments or strata of Holocene age.

8. Displacement during historic time (e.g. San Andreas fault 1906).

9. Includes areas of known fault creep.

10. Fault offsets seafloor sediments or strata of Late Pleistocene age.

11. Fault offsets Late Pleistocene strata.

12. Fault offsets late Pleistocene or older strata.
APPENDIX A: FIELD INVESTIGATION

The field investigation consisted of a surface reconnaissance and a subsurface exploration program using truck-mounted, hollow-stem auger drilling equipment. Two, 8-inch-diameter exploratory borings were drilled on March 29, 2018 to a depth of 20 feet. The approximate locations of exploratory borings are shown on the Site Plan, Figure 2. The soils encountered were continuously logged in the field by our representative and described in accordance with the Unified Soil Classification System (ASTM D2488). Boring logs, as well as a key to the classification of the soil, are included as part of this appendix.

Boring locations were approximated using existing site boundaries and other site features as references. Boring elevations were based on interpolation of provided plans determined. The locations of the borings should be considered accurate only to the degree implied by the method used.

Representative soil samples were obtained from the borings at selected depths. All samples were returned to our laboratory for evaluation and appropriate testing. The standard penetration resistance blow counts were obtained by dropping a 140-pound hammer through a 30-inch free fall. The 2-inch O.D. split-spoon sampler was driven 18 inches and the number of blows was recorded for each 6 inches of penetration (ASTM D1586). 2.5-inch I.D. samples were obtained using a Modified California Sampler driven into the soil with the 140-pound hammer previously described. Unless otherwise indicated, the blows per foot recorded on the boring log represent the accumulated number of blows required to drive the last 12 inches. The various samplers are denoted at the appropriate depth on the boring logs.

Field tests included an evaluation of the unconfined compressive strength of the soil samples using a pocket penetrometer device. The results of these tests are presented on the individual boring logs at the appropriate sample depths.

Attached boring logs and related information depict subsurface conditions at the locations indicated and on the date designated on the logs. Subsurface conditions at other locations may differ from conditions occurring at these boring locations. The passage of time may result in altered subsurface conditions due to environmental changes. In addition, any stratification lines on the logs represent the approximate boundary between soil types and the transition may be gradual.
### Unified Soil Classification (ASTM D-2487-98)

<table>
<thead>
<tr>
<th>Material Types</th>
<th>Criteria for Assigning Soil Group Names</th>
<th>Group Symbol</th>
<th>Soil Group Names &amp; Legend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gravels</td>
<td>Clean Gravels &lt;5% fines</td>
<td>Cu&lt;4 AND 1&lt;Co&lt;3</td>
<td>GW WELL-GRADED GRAVEL</td>
</tr>
<tr>
<td></td>
<td>Gravels with fines &gt;12% fines</td>
<td>Co-classify as ML or CL</td>
<td>GM SILTY GRAVEL</td>
</tr>
<tr>
<td>Coarse-Grained Soils &gt;50% retained on No. 4 sieve</td>
<td>Clean Sands &lt;5% fines</td>
<td>Cu&lt;6 AND 1&lt;Co&lt;3</td>
<td>SW WELL-GRADED SAND</td>
</tr>
<tr>
<td></td>
<td>Sands with fines &gt;12% fines</td>
<td>Co-classify as ML or CL</td>
<td>SP POORLY-GRADED SAND</td>
</tr>
<tr>
<td>Fine-Grained Soils &gt;50% passes on No. 200 sieve</td>
<td>Sands and fines &gt;12% fines</td>
<td>Co-classify as ML or CL</td>
<td>SM SILTY SAND</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>SC CLAYEY SAND</td>
</tr>
<tr>
<td>Highly Organic Soils</td>
<td>Primarily organic matter, dark in color, and organic odor</td>
<td></td>
<td>PT PEAT</td>
</tr>
</tbody>
</table>

### Additional Tests

- **SPT (Standard Penetration Test)**
- **PI (Plasticity Index)**
- **Swell Test**
- **Cyclic Triaxial Test**
- **Torvane Shear Test**
- **UU (Unconfined Compression)**
- **(1.5)** (With shear strength in KSF)

### Penetration Resistance (Recorded as blows / foot)

<table>
<thead>
<tr>
<th>SAND &amp; GRAVEL</th>
<th>SILT &amp; CLAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative Density</td>
<td>BLOWS/FOOT*</td>
</tr>
<tr>
<td>Very Loose</td>
<td>0 - 4</td>
</tr>
<tr>
<td>Loose</td>
<td>4 - 10</td>
</tr>
<tr>
<td>Medium Dense</td>
<td>10 - 30</td>
</tr>
<tr>
<td>Dense</td>
<td>30 - 50</td>
</tr>
<tr>
<td>Very Dense</td>
<td>Over 50</td>
</tr>
<tr>
<td>Hard</td>
<td>Over 30</td>
</tr>
</tbody>
</table>

* Number of blows of 140 lb hammer falling 30 inches to drive a 2 inch O.D. (1.38 inch I.D.) split-barrel sampler the last 12 inches of an 18-inch drive (ASTM-1586 Standard Penetration Test).

---

**LEGEND TO SOIL DESCRIPTIONS**

Figure Number A-1
### BORING NUMBER EB-1

**DATE STARTED** 3/29/18  
**DATE COMPLETED** 3/29/18  
**DRILLING CONTRACTOR** Exploration Geoservices, Inc.  
**DRILLING METHOD** Mobile B-61, 8 inch Hollow-Stem Auger  
**LOGGED BY** RPM  
**NOTES**

**GROUND WATER LEVELS:**
- **AT TIME OF DRILLING** Not Encountered
- **AT END OF DRILLING** Not Encountered

<table>
<thead>
<tr>
<th>ELEVATION (ft)</th>
<th>SYMBOL</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>333.0</td>
<td></td>
<td>8 inches asphalt concrete over 4 inches aggregate base</td>
</tr>
</tbody>
</table>
| 332.3          | SGS    | Silty Sand with Gravel (SM)  
dry to moist, brown, fine to medium sand, fine to coarse subangular to subrounded gravel |
| 332.0          |        | Clayey Sand with Gravel (SC)  
very dense to dense, moist, brown, fine to coarse sand, fine to coarse subangular to subrounded gravel, sandstone cobbles (sandstone and shale) |
| 330.0          |        | Lean Clay with Sand (CL)  
stiff, moist, brown, fine sand, some fine subangular to rounded gravel, moderate plasticity |
| 319.0          |        | Poorly Graded Gravel with Clay and Sand (GP-GC)  
very dense, moist, brown, fine to coarse subangular to rounded gravel, fine to medium sand |
| 316.0          |        | Bottom of Boring at 20.0 feet. |

**GROUND ELEVATION** 333 FT +/-  
**BORING DEPTH** 20 ft.  
**LATITUDE**  
**LONGITUDE**

### UNCONFINED COMPRESSION

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>UNCONSOLIDATED-UNDRAINED TRIAXIAL</th>
<th>UNDRAINED SHEAR STRENGTH, ksf</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>G-236</td>
<td>1.0 2.0 3.0 4.0</td>
</tr>
</tbody>
</table>

**NATURAL MOISTURE CONTENT**

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>HAND PENETROMETER</th>
<th>TENVANE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

**PLASTICITY INDEX, %**

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>HAND PENETROMETER</th>
<th>TENVANE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

**PERCENT PASSING No. 200 SIEVE**

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>HAND PENETROMETER</th>
<th>TENVANE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

**DRY UNIT WEIGHT**

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>HAND PENETROMETER</th>
<th>TENVANE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

**N-VALE (uncorrected) blows per foot**

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>HAND PENETROMETER</th>
<th>TENVANE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

**SAMPLES TYPE AND NUMBER**

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>TYPE AND NUMBER</th>
<th>DEPTH (ft)</th>
<th>DRY UNIT WEIGHT</th>
<th>NATURAL MOISTURE CONTENT</th>
<th>NATURAL DENSITY</th>
<th>PLASTICITY INDEX, %</th>
<th>PERCENT PASSING No. 200 SIEVE</th>
<th>UNCONSOLIDATED-UNDRAINED TRIAXIAL</th>
<th>UNDRAINED SHEAR STRENGTH, ksf</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>115</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>5</td>
<td>115</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
<td>115</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>15</td>
<td>115</td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td>20</td>
<td>115</td>
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<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

**PROJECT NAME** Tennant Avenue Sewer Improvements  
**PROJECT NUMBER** 522-9-1  
**PROJECT LOCATION** Morgan Hill, CA  
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**PROJECT NAME** Tennant Avenue Sewer Improvements  
**PROJECT NUMBER** 522-9-1  
**PROJECT LOCATION** Morgan Hill, CA
### DESCRIPTION

- **Sandy Lean Clay with Gravel (CL)**
  - moist, brown, fine sand, fine to coarse subangular to subrounded gravel, low plasticity

- **Lean Clay with Sand (CL)**
  - hard, moist, brown, fine sand, moderate plasticity

- Liquid Limit = 35, Plastic Limit = 17

- subrounded sandstone/shale gravel

- Bottom of Boring at 20.0 feet.
APPENDIX B: LABORATORY TEST PROGRAM

The laboratory testing program was performed to evaluate the physical and mechanical properties of the soils retrieved from the site to aid in verifying soil classification.

**Moisture Content:** The natural water content was determined (ASTM D2216) on 8 samples of the materials recovered from the borings. These water contents are recorded on the boring logs at the appropriate sample depths.

**Dry Densities:** In place dry density determinations (ASTM D2937) were performed on 8 samples to measure the unit weight of the subsurface soils. Results of these tests are shown on the boring logs at the appropriate sample depths.

**Plasticity Index:** One Plasticity Index determination (ASTM D4318) was performed on a sample of the subsurface soil to measure the range of water contents over which this material exhibits plasticity. The Plasticity Index was used to classify the soil in accordance with the Unified Soil Classification System and to evaluate the soil expansion potential. Results of this test is shown on the boring log at the appropriate sample depth.
### Plasticity Index (ASTM D4318) Testing Summary

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Boring No.</th>
<th>Depth (ft)</th>
<th>Natural Water Content (%)</th>
<th>Liquid Limit (%)</th>
<th>Plastic Limit (%)</th>
<th>Plasticity Index</th>
<th>Passing No. 200 (%)</th>
<th>Group Name (USCS - ASTM D2487)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EB-2</td>
<td>9.0</td>
<td>20</td>
<td>35</td>
<td>17</td>
<td>18</td>
<td>—</td>
<td>Lean Clay with Sand (CL)</td>
</tr>
</tbody>
</table>

**Diagram:**

- CL: Clay
- CH: Chamosite
- OH or MH: Organic/Humus or Montmorillonite
- OL or ML: Organic/Limy or Montmorillonite

**Legend:**

- Solid circle: Natural
- X: Water content

**Graph Axes:**

- Plasticity Index (%)
- Liquid Limit (%)