Appendix D

Geotechnical Report

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October 7, 2021
Project 1822-2

ALCO IRON & METAL
2140 Davis Street
San Leandro, CA 94577

Attention: Michael Bercovich

Gentlemen:

Geotechnical Investigation
Proposed Improvements, Alco Iron & Metal Facility
Doolittle Drive
San Leandro, California

As you authorized, presented herein are the results of the geotechnical investigation and liquefaction evaluation of the subsurface soil at the property where improvements are proposed. The property is facility is located at the northwest corner of the intersection of Davis Street with Doolittle Drive in San Leandro, California. The accompanying report with attachments has been prepared for your use in developing the property for the proposed improvements. We understand that the originally proposed improvements have been scaled down as shown on the revised site plan prepared by CRJ Architects, Inc., and dated April 30, 2021. The report describes the general site geotechnical characteristics, identifies potential geotechnical hazards that may impact the proposed development and provides geotechnical input for site development and construction of the proposed building foundations. Based on the revised site plan, the recommendations provided in the report are valid for the planned improvements. We should be allowed the opportunity to review the final development plans when they become available. This concludes our work for the current phase of the project.

We appreciate the opportunity to have provided geotechnical services for this project and look forward to working with you again in the future.

Sincerely,

FRIAR ASSOCIATES, INCORPORATED

John H. Friar
CE 52281

Attachment

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GEOTECHNICAL INVESTIGATION
AND LIQUEFACTION EVALUATION
PROPOSED INDUSTRIAL BUILDING
DOOLITTLE DRIVE
SAN LEANDRO, CALIFORNIA

INTRODUCTION

This report presents the results of the geotechnical investigation and liquefaction evaluation we conducted at the site for the planned industrial buildings for the Alcoa Iron and Metal Company. The proposed building sites are located in area at the northwest corner of the intersection of Davis Street with Doolittle Drive in San Leandro, California. The general location of the site is shown on the attached Vicinity Map, Figure 1.

BACKGROUND

Alco Iron and Metal plans to add on to their existing building located at the northwest corner of the intersection of Davis Street and Doolittle Drive. Further to the west of the existing building, Alco Iron and Metal plan to support an existing mobile office on permanent foundations. In addition, Alco Metal and Iron plans to pave another area between the planned addition site and the mobile office and use the area for parking.

PROPOSED CONSTRUCTION

Details of the proposed development were not available at the time of preparing this report. However, we have assumed that the proposed industrial building addition will be of either wood or steel frame construction with a concrete slab-on-grade floor. We understand that the mobile office will be supported on a permanent foundation system and no other improvements will be done to the structure. The new parking area will be asphalt concrete. The existing conditions at the proposed construction area are shown on the attached Site Plan, Figure 2.

INFORMATION PROVIDED

We were provided with an electronic format (pdf) copy of a site plan showing the proposed addition site, the mobile office structure and the area proposed for the new at-grade parking. The site plan (no date) was prepared by CRJ Architects, Inc. We were provided with a site topographic map showing the existing site conditions. The site topographic map dated November 2017, was prepared by Kier & Wright Civil Engineers. A copy of the site plan by CRJ Architects was used to prepare our Site Plan, Figure 2 which also shows the approximate location of the exploratory holes we excavated as part of this investigation.

SCOPE OF WORK

Our scope of work was to evaluate the site conditions (surface and subsurface) from a geotechnical engineering viewpoint and to develop information for the design and construction of the proposed building foundations and other geotechnically related portions of the planned construction. Specifically, we performed the following work:

1. Made a site reconnaissance visit and site meeting with a representative of Alco Iron and Metal to evaluate the existing conditions at the site and plan the field exploration work.

2. Reviewed geologic and geotechnical information in our files pertinent to the site and the surrounding area.

3. Reviewed in-house files for projects we have completed in the vicinity of the site. We specifically reviewed our files for the work we did for the new Alco Iron and Metal building on Davis Street.

4. Explored, sampled and classified foundation soils by means of three small diameter exploratory holes to a maximum depth of 50 feet below the existing ground surface. The holes were logged by an engineer on staff who supervised the field exploration work and obtained samples for laboratory testing.

5. Performed laboratory testing on selected soil samples to evaluate their pertinent index and mechanical properties.

6. Collated and analyzed the field and laboratory data obtained to evaluate the liquefaction potential of the site subsurface soils under seismic loading and to provide recommendations and mitigation measures, if found necessary.

7. Based on the findings of the six items above, developed geotechnical recommendations for site preparation, grading and compaction; provided geotechnical information for the design and construction of the proposed building foundations, concrete slabs-on-grade, utility trench backfilling and site drainage.

8. Provided a minimum pavement sections for the driveway and parking areas.

9. Prepared this report to summarize our findings, conclusions and recommendations.

FINDINGS

Surface Conditions

The three sites for the planned construction are part of a large parcel of land located on the northwest corner of the intersection of Davis Street with Doolittle Drive. The referenced parcel consists of some industrial structures and open spaces that are generally used for storing scrap metals. The ground surface at the three sites is essentially level. The site for the proposed addition to the existing building is paved with asphalt concrete. The other two areas are unpaved. The average ground elevation at the site is between seven and eight feet above Mean Sea Level.

Subsurface Conditions

The descriptions given below pertain only to the subsurface conditions found at the site at the time of our subsurface exploration on June 4, 2018. Subsurface conditions, particularly ground water levels and the consistency of the near-surface soils, will vary with time and the seasons.

Subsurface conditions at the site were explored by means of three small diameter exploration holes to a maximum depth of 50 feet below the existing ground surface. Within the depth of our exploration, the exploratory holes encountered fill, clay, silt, sand and gravel.

The fill encountered consist of crushed rock and brown silty clay with brick pieces, asphalt concrete and some crushed rock. The fill is estimated to be between 24 inches and 36 inches in thickness. The near-surface native soils consist of dark gray to black moderately to highly plastic silty clay that is moist and stiff. This highly plastic clay extends to a depth of about 10 feet below the existing ground surface. Below 10 feet, the clay grades lighter in color to brown and greenish-brown with some sand. A layer of sand about 15 feet in thickness was encountered below the clay. The sand is saturated and medium dense. The sand is underlain by sandy clay to the maximum depth of exploration.

Groundwater was encountered at a depth of five feet and seven feet below the ground surface at the exploratory holes. The groundwater stabilized at those depths. Depth to groundwater is expected to fluctuate with time and the seasons.

Detailed descriptions of the materials encountered in the borings are given on the appended boring logs together with the results of some of the laboratory tests performed on selected samples obtained from the borings (see Appendix B). The results of the other laboratory tests are attached separately under Appendix C.

Seismic Considerations

This site is located within the seismically active San Francisco Bay region but outside of any of the Alquist-Priolo Earthquake Fault Zones.

Type A and Type B faults close to the site are listed in the following table.

TABLE 1 - TYPES A AND B FAULTS CLOSE TO THE SITE *

Fault	Type	Maximum Moment Magnitude	Slip Rate (mm/yr)	Distance (miles/km)
San Andreas (1906 Segment)	A	7.9	24	14.9/24
Hayward (Total Length)	A	7.1	9	3.1/5
Calaveras (North of Reservoir)	B	6.8	0.4	11.8/19

* California Division of Mines & Geology Open File Report 96-08

Seismic hazards can be divided into two general categories, hazards due to ground rupture and hazards due to ground shaking. Since no active faults are known to cross this property, the risk of earthquake-induced ground rupture occurring across the project site appears to be remote.

Should a major earthquake with an epicentral location close to the site occur, ground shaking at the site will undoubtedly be severe, as will be for other properties in the general vicinity of the site. Under the influence of severe ground shaking, the soils that underlie the area proposed may liquefy resulting in differential settlement across the project site and the adjacent area (see liquefaction analysis below).

The following general site seismic design information may be used in accordance with the 2016 California Building Code.

Site Coordinates: Latitude = 37.72; Longitude = -122.19
Site Class: D
Fa = 1.0, and Fv = 1.5

Spectral Response Accelerations SMs and SM1
SMs = FaSs and SM1 = FvS1
For Site Class D with Fa = 1.0, and Fv = 1.5

Period (sec)	Sa (g)	
0.2	1.748	(SMs, Site Class D)
1.0	1.041	(SM1, Site Class D)

SDs = 2/3 x SMs and SD1 = 2/3 x SM1
For Site Class D with Fa = 1.0, Fv = 1.5

Period (sec)	Sa (g)	
0.2	1.165	(SDs, Site Class D)
1.0	0.694	(SD1, Site Class D)

Liquefaction Analysis

Liquefaction is a commonly observed phenomenon during an earthquake. Liquefaction occurs when saturated sands lose their strength during an earthquake and become fluid-like and mobile. As a result, the ground may undergo large permanent displacements that can damage underground utilities and well-built surface structures. The displacements can either be vertical that may result in differential settlement or lateral spread. Lateral spreading is a major concern associated with liquefaction because it involves displacement of large blocks of ground down gentle slopes or towards stream channels.

We performed a liquefaction evaluation using a 7.5 Magnitude earthquake resulting in a peak ground acceleration of 0.61g (in accordance with Open File Report 2000-010) at the site. A groundwater level of 10 feet below the ground surface was used to perform the liquefaction evaluation. The results of the liquefaction analysis are shown on Appendix A.

Methodology

We performed the analysis using a software developed by CIVILTECH. The CIVILTECH software method is based on the most recent publications of the NCEER Workshop and DMG SP 117 Implementation. The software provides several methods for evaluating liquefaction potential including Seed's normalized SPT blow counts, BPT and CPT data. Our analysis was based on Seed's normalized SPT method. The calculation procedure used is divided into four parts:

1. Calculation of *cyclic stress ratio* (CSR, earthquake "load") induced in the soil by an earthquake.

2. Calculation of *cyclic resistance ratio* (CRR, soil "strength") based on in-situ test

data from SPT tests.

3. Evaluation of liquefaction potential by calculating a *factor of safety against liquefaction,* F.S., by dividing CRR by CSR.

4. Estimation of liquefied-induced settlement.

1. **Cyclic Stress Ration** is calculated using Seed's method, first introduced in 1971 (Seed and Idriss, 1971) and updated through summary papers by Seed and others and recently (1996) reviewed by participants in a workshop on liquefaction evaluation arranged by NCEER. The equation is as follows:

$$CSR = 0.65\sigma_0/\sigma_0' a_{max}\, r_d$$

where,

CSR is the cyclic stress ratio induced by a given earthquake

0.65 is a weighting factor introduced by Seed, to calculate the number of uniform stress cycles required to produce the same pore water pressure as an irregular earthquake ground motion.

σ_0 is the total vertical overburden stress

σ_0' is the effective vertical overburden stress

a_{max} is the Peak Horizontal Ground Acceleration, PGA, in g

r_d is a stress reduction coefficient determined by the formulas below (NCEER, 1997)

$r_d=1.0-0.00765z$ for $z< 9.15m$
$r_d=1.174-0.0267z$ for $9.15m<z<30m$
$r_d=0.5$ For $z>30m$

2. **Cyclic Resistance Ratio** (CRR) liquefaction curves are derived for an earthquake magnitude of 7.5 and is designated as $CRR_{7.5}$. To take different magnitudes into account, the factor of safety against liquefaction is multiplied by a magnitude scaling factor (MSF). In the graphical output of the analysis, the CSR is divided by the MSF to give an accurate view of the liquefied zone. The computation of $CRR_{7.5}$ from SPT is based on correction for the following:

blow count data (N_m)

depth correction factor (C_n)
hammer energy ratio (ER) correction factor (C_e)
borehole diameter correction factor (C_b)
rod length correction factor (C_r)
correction factor for samples with or without liners (C_s)

$CRR_{7.5}$ is determined by using a formula developed by Blake (1997). Blake used the corrected normalized SPT–value $(N_1)_{60}$.

3. **Ratio of CRR/CSR** The ratio of CRR/CSR is defined as Factor of Safety for liquefaction potential. If FS>1 or equal to 1, there is no potential for liquefaction. If F.S < 1, there is a potential of liquefaction.

4. **Settlement Calculation** is done in two parts, dry soil settlement and saturated soil settlement. The soil above the groundwater table is referred to as dry soil and soil below the groundwater table is referred to as saturated soil. **The total settlement is presented in the graphical report as a cumulative settlement curve versus depth**.

To evaluate the liquefaction induced lateral movement in the ground surface that could occur at the site as a result of a 7.5 Magnitude earthquake on the nearby Hayward Fault, an empirical method developed by Bartlett and Youd (1995) was used. The following equation was used: the equation is for determining lateral spreading of gently sloping ground as opposed to a free face.

$$\text{Log } D_H = -15.787+1.178M-0.927\log R-0.013R+0.429\log S+0.348\log T+4.527\log(100-F)-0.922D_{50}$$

where,

D_H is the ground displacement in meters
M is earthquake Magnitude
R is distance to the nearest fault rupture in kilometers
T is Cumulative thickness of the liquefiable soil layer in meters
F is percent finer than No. 200 sieve
D_{50} is grain size corresponding to 50% fine of liquefiable soil layer in millimeters
S is slope gradient of the ground surface

The data obtained from the laboratory tests was used to perform our analysis.

Our analysis shows that with a 7.5 Magnitude earthquake and a groundwater level at seven feet below the ground surface, there is a potential for liquefaction at the site which may result in total

estimated cumulative ground settlement of a little over **six inches** with **total differential settlement of between three and four inches across the site**. Lateral ground displacement is estimated to be almost unnoticeable as a result of a seismic event producing a ground liquefaction at the site given the site conditions (almost flat ground surface at the proposed building area as opposed to free face). Historical data does not indicate the effects of large scale lateral spreading at or near the vicinity of the property.

DISCUSSION

The principal geotechnical items that will impact the planned construction is the presence of undocumented fill near the surface of the proposed building site. The undocumented fill cannot be relied on to take the proposed building loads. This fill should be removed and replaced as structural fill.

Atterberg Limits tests performed on a sample of the near-surface clay shows the clay is moderately to highly plastic indicating a moderate to high potential for expansion. Expansive soil loses volume and shrinks when dry and expand when it gains water. The degree of expansion depends on the antecedent soil water content. The alternating shrink/swell cycles of expansive soils tend to have detrimental effects on foundation elements, particularly, slabs-on-grade. Foundation and concrete slabs-on-grade for the proposed building should be designed with this in mind.

To provide uniform support for the new building, we recommend that the top 24 inches of the new building pad be subexcavated and replaced with non-expansive fill cap. The new building may then be supported on conventional, shallow, footing-type foundations. Detail recommendations are provided in a section below.

RECOMMENDATIONS

The following recommendations, which are presented as guidelines to be used by project planners and designers, have been prepared assuming FRIAR ASSOCIATES, INCORPORATED will be commissioned to review the grading and foundation plans prior to construction, and to observe and test during site grading and foundation construction. This additional opportunity to inspect the project site will allow us to compare subsurface conditions exposed during construction with those that were observed during this investigation.

Site Preparation, Grading and Compaction

The site should be cleared of all unsuitable material and hauled off site. Areas of the site that are

landscaped and will be built on or paved should be stripped to remove organic-laden topsoil. Soils containing more than two percent by weight of organic matter should be considered organic. Any subsurface structure including old utility lines and buried pipes, electrical lines, landscape pipes, sanitary sewers and storm drains that may exist at the property and traverses the new building pad, should be excavated out, removed and hauled off-site or relocated away from the proposed building and pavement sites. The resulting voids and depressions from these operations should be backfilled with structural fill.

To provide uniform support for the proposed building, we recommend that the top 24 inches of soil exposed in the proposed building addition area and pavement areas after the removal of the unsuitable material be excavated out and replaced as structural fill. This subexcavation should extend at least five feet beyond the proposed building addition lines and three feet beyond new pavement edges. The soil exposed after the subexcavation should be scarified, conditioned with water (or allowed to dry) to a soil water content of at least three percent above the optimum water content and compacted to about 90 percent of the maximum dry density as determined by ASTM Test Method D1557-12.

Structural fill may then be placed up to design grades in the proposed building and pavement areas. Structural fill using approved import, should be placed in layers, each not exceeding eight inches thick (before compaction), conditioned with water (or allowed to dry, as necessary) to produce a soil water content of at least three percent above the optimum water content and then compacted to 90 percent relative compaction based on ASTM Test Method D1557-12.

Import soil required for use as structural fill, should be inorganic, should preferably have a low expansion potential and should be free from clods or rocks larger than four inches in largest dimension. Prior to delivery to the site, proposed import should be tested in our laboratory to verify its suitability for use as structural fill and, if found to be suitable, further tested to estimate the water content and density at which it should be placed.

New Building Foundations

The new buildings may be supported on conventional, shallow foundations bearing on properly compacted fill as recommended above under "Site Preparation, Grading And Compaction" or bearing on competent native, "undisturbed" soil.

Continuous, reinforced concrete foundations may be designed to impose pressures on foundation soils up to 2000 pounds per square foot from dead plus normal live loading. Continuous foundations should be at least 18 inches wide and should be embedded at least 24 inches below rough pad grade or adjacent finished grade, whichever is lower. <u>For the mobile office, foundation excavations should be at least 12 inches deep and 12 inches wide in smallest dimensions.</u>

Interior isolated foundations, such as may support column loads, may be designed to impose pressures on foundation soils up to 2000 pounds per square foot from dead plus normal live loading. Interior foundations should be embedded at least 24 inches below rough pad grade and should be at least 24 inches in smallest dimension.

The allowable soil pressures given above may be increased by one-third when evaluating the effects of short-term wind or seismic loadings

Total and differential post-construction settlement of foundations constructed as recommended above should be nominal.

For design purposes, horizontal passive resistance acting against foundations embedded in level native soil or compacted fill may be calculated assuming an equivalent fluid pressure of 250 pounds per cubic foot. The upper nine inches of embedment should be neglected when calculating horizontal passive resistance of the soil against the foundations unless the ground surface is paved. Alternatively, the ultimate horizontal friction force acting along the base of foundations may be calculated using a soil to concrete friction coefficient of 0.30. When both passive resistance and friction are combined, the lower value of the two should be reduced by 50 percent.

During foundation construction, care should be taken to minimize evaporation of water from foundation and floor subgrades. Scheduling the construction sequence to minimize the time interval between foundation excavation and concrete placement is important. Concrete should be placed only in foundation excavations that have been kept moist, are free from drying cracks and contain no loose or soft soil or debris. It is very critical that soil water content is maintained at least three percent over the optimum water content prior to placement of concrete.

Concrete Slabs-On-Grade

Concrete floor slabs should be constructed on compacted soil subgrades prepared as described in the section on Site Preparation, Grading and Compaction. Clayey subgrade for concrete slabs-on-grade areas should be water conditioned as recommended above to minimize post-construction detrimental effect of expansive soil. **It is important that concrete is placed only at subgrade soils that have been kept moist, particularly, for slab-on-grade areas.**

To minimize floor dampness, a section of capillary break material at least five inches thick and covered with a membrane vapor barrier should be placed between the floor slab and the compacted soil subgrade. The capillary break should be a free-draining material, such as 3/8" pea gravel or a permeable aggregate complying with CALTRANS Standard Specifications, Section 68, Class 1, Type A or Type B. The membrane vapor barrier should be a high quality. A protective cushion of sand or capillary break material at least two inches thick should be placed

between the membrane vapor barrier and the floor slab.

If floor dampness is not objectionable, concrete slabs may be constructed directly on a minimum six-inch thick compacted aggregate base over the water-conditioned and compacted soil subgrade. The aggregate base material should be compacted to at least 93 percent of the maximum dry density as determined by ASTM Test Method D1557-09.

Driveway Pavement

The near-surface soil at the site will have low support when used for pavement support; therefore, an R-value of 10 was assumed in pavement design calculations shown below. We recommend that R-value test of the pavement subgrade soil be performed when roadway subgrades are established to determine the actual pavement sections required based on projected Traffic Indices. Therefore, the design sections shown in the table below are preliminary.

TABLE 2 - RECOMMENDED MINIMUM ASPHALT CONCRETE PAVEMENT SECTIONS

Traffic Index (T.I.)	Asphalt Concrete (inches)	Class 2 Aggregate Base (inches)	Total Thickness (inches)
4.5	2.5	9.0	11.5
5.0	3.0	9.0	12.0
5.5	3.5	10.0	13.5
6.0	4.0	11.0	15.0

Pavement subgrades should be compacted as described above in the section under "Site Preparation Grading and Compaction".

Curbs and gutters should be constructed directly on the soil subgrade rather than on a layer of aggregate base. This will minimize the amount of surface water that seeps below the curb and into the pavement subgrade. The seepage of water into subgrade soils beneath vehicle pavements, can result in subgrade softening and premature pavement distress.

Pavement construction should comply with the requirements of the CALTRANS Standard Specifications, latest editions, except that compaction requirements for pavement soil subgrades and aggregate base should be based on ASTM Test D1557-09, as described in the part of this report dealing with "Site Preparation, Grading and Compaction."

For a concrete driveway, the recommendations under Concrete Slab-On-Grade may be used for

light traffic. If heavier traffic is anticipated, the slab should be evaluated by the project structural engineer. The concrete slab should be at least four inches thick and should be reinforced with a minimum of No. 4 reinforcing bars. Reinforcing bars should have a minimum clear cover of 1.5 inches.

Utility Trenches

The attention of contractors, particularly the underground contractor, should be drawn to the requirements of California Code of Regulations, Title 8, Construction Code Section 1540 regarding Safety Orders for "Excavations, Trenches, Earthwork." Any temporary excavation deeper than five feet should be adequately shored. Temporary shoring may be designed using a lateral pressure of 45 pounds per cubic foot.

For purposes of this section of the report, bedding is defined as material placed in a trench up to one foot above any utility pipe and backfill is all material placed in the trench above the bedding.

Unless concrete bedding is required around utility pipes, free-draining sand should be used as bedding. Sand proposed for use in bedding should be tested in our laboratory to verify its suitability and to measure its compaction characteristics. Sand bedding should be compacted by mechanical means to achieve at least 90 percent compaction density based on ASTM Test Method D1557-12.

Approved, on-site, inorganic soil, or imported material may be used as utility trench backfill. Proper compaction of trench backfill will be necessary under and adjacent to structural fill, building foundations, concrete slabs and vehicle pavements. In these areas, backfill should be conditioned with water (or allowed to dry) to produce a soil-water content of about five percent above the optimum value and placed in horizontal layers not exceeding six inches in thickness (before compaction). Each layer should be compacted to 85-90 percent relative compaction based on ASTM Test D1557-12. The upper eight inches of pavement subgrades should be compacted to about 90 percent relative compaction based on ASTM Test D1557-12.

Where any trench crosses the perimeter foundation line of any building, the trench should be completely plugged and sealed with compacted clay soil for a horizontal distance of at least two feet on either side of the foundation.

Surface Drainage

Surface drainage gradients should be planned to prevent ponding and to promote drainage of surface water away from top of slopes, building foundations, slabs, edges of pavements and sidewalks, and toward suitable collection and discharge facilities.

Water seepage or the spread of extensive root systems into the soil subgrades of foundations, slabs, or pavements, could cause differential movements and consequent distress in these structural elements. This potential risk should be given due consideration in the design and construction of landscaping.

Subsurface Drainage

Due to high groundwater conditions at the property, it will be prudent to install subsurface drains around the perimeter of the new building foundations. We can provide recommendations for subsurface drainage system should project planners and designers decide to incorporate one as part of the proposed development.

Follow-up Geotechnical Services

Our recommendations are based on the assumption that FRIAR ASSOCIATES, INCORPORATED will be commissioned to perform the following services.

1. Review final grading and foundation plans prior to construction.

2. Observe, test and advise during grading, subexcavation for the proposed building pad and placement of structural fill.

3. Observe and advise during proposed building foundation excavations.

4. Observe, test and advise during utility trench backfilling.

LIMITATIONS

The recommendations contained in this report are based on certain plans, information and data that have been provided to us. Any change in those plans, information and data will render our recommendations invalid unless we are commissioned to review the change and to make any necessary modifications and/or additions to our recommendations.

Subsurface exploration of any site is necessarily confined to selected locations. Conditions may, and often do, vary between and around such locations. Should conditions different from those encountered in our explorations come to light during project development, additional exploration, testing and analysis may be necessary; changes in project design and construction may also be necessary.

Our recommendations have been made in accordance with the principles and practices generally

employed by the geotechnical engineering profession. This is in lieu of all other warranties, express or implied.

Should conditions different from those assumed in this report come to light during project development, additional exploration, testing and analysis may be necessary; changes in project design and construction may also be necessary.

All earthwork and associated construction should be observed by our field representative, and tested where necessary, to compare the generalized site conditions assumed in this report with those found at the site at the time of construction, and to verify that construction complies with the intent of our recommendations.

Report prepared by:

FRIAR ASSOCIATES, INCORPORATED

John H. Friar
CE 52281

Appendix A

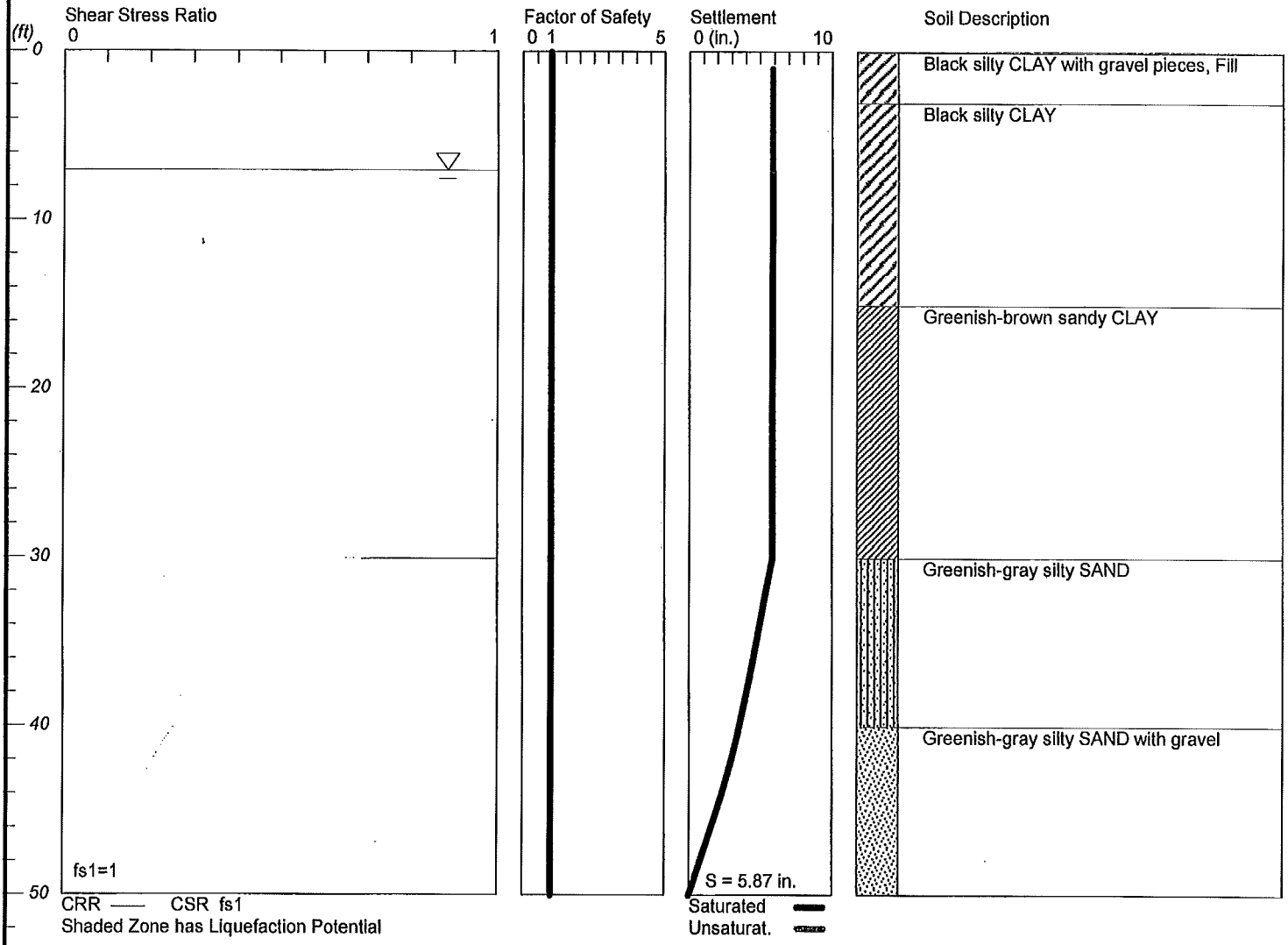
Liquefaction Analysis Results

LIQUEFACTION ANALYSIS

Proposed Industrial Building

Hole No.=B-1 Water Depth=7 ft Surface Elev.=15

Magnitude=7
Acceleration=0.65g



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LIQUEFACTION ANALYSIS SUMMARY

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Input File Name: C:\Users\JohnF\Desktop\STORE N GO\1822-2.liq
Title: Proposed Industrial Building
Subtitle: 1091 Doolottle Ave., San Leandro, CA

Surface Elev.=15
Hole No.=B-1
Depth of Hole= 50.00 ft
Water Table during Earthquake= 7.00 ft
Water Table during In-Situ Testing= 7.00 ft
Max. Acceleration= 0.65 g
Earthquake Magnitude= 7.00

Input Data:
Surface Elev.=15
Hole No.=B-1
Depth of Hole=50.00 ft
Water Table during Earthquake= 7.00 ft
Water Table during In-Situ Testing= 7.00 ft
Max. Acceleration=0.65 g
Earthquake Magnitude=7.00
No-Liquefiable Soils: CL, OL are Non-Liq. Soil

1. SPT or BPT Calculation.
2. Settlement Analysis Method: Ishihara / Yoshimine
3. Fines Correction for Liquefaction: Idriss/Seed
4. Fine Correction for Settlement: During Liquefaction*
5. Settlement Calculation in: All zones*
6. Hammer Energy Ratio, Ce = 1
7. Borehole Diameter, Cb= 1
8. Sampling Method, Cs= 1
9. User request factor of safety (apply to CSR) , User= 1
   Plot one CSR curve (fs1=1)
10. Use Curve Smoothing: Yes*
* Recommended Options

In-Situ Test Data:

Depth	SPT	gamma	Fines

ft		pcf	%
1.00	13.00	124.80	NoLiq
5.00	14.00	118.00	NoLiq
10.00	15.00	97.80	NoLiq
15.00	11.00	100.10	NoLiq
20.00	16.00	123.10	NoLiq
25.00	13.00	120.20	NoLiq
30.00	14.00	115.50	47.38
40.00	22.00	125.00	3.87
45.00	12.00	120.00	10.41

Output Results:

Settlement of Saturated Sands=5.87 in.
Settlement of Unsaturated Sands=0.00 in.
Total Settlement of Saturated and Unsaturated Sands=5.87 in.
Differential Settlement=2.937 to 3.877 in.

Depth ft	CRRm	CSRfs	F.S.	S_sat. in.	S_dry in.	S_all in.
1.00	2.00	0.42	5.00	5.87	0.00	5.87
1.05	2.00	0.42	5.00	5.87	0.00	5.87
1.10	2.00	0.42	5.00	5.87	0.00	5.87
1.15	2.00	0.42	5.00	5.87	0.00	5.87
1.20	2.00	0.42	5.00	5.87	0.00	5.87
1.25	2.00	0.42	5.00	5.87	0.00	5.87
1.30	2.00	0.42	5.00	5.87	0.00	5.87
1.35	2.00	0.42	5.00	5.87	0.00	5.87
1.40	2.00	0.42	5.00	5.87	0.00	5.87
1.45	2.00	0.42	5.00	5.87	0.00	5.87
1.50	2.00	0.42	5.00	5.87	0.00	5.87
1.55	2.00	0.42	5.00	5.87	0.00	5.87
1.60	2.00	0.42	5.00	5.87	0.00	5.87
1.65	2.00	0.42	5.00	5.87	0.00	5.87
1.70	2.00	0.42	5.00	5.87	0.00	5.87
1.75	2.00	0.42	5.00	5.87	0.00	5.87
1.80	2.00	0.42	5.00	5.87	0.00	5.87
1.85	2.00	0.42	5.00	5.87	0.00	5.87
1.90	2.00	0.42	5.00	5.87	0.00	5.87
1.95	2.00	0.42	5.00	5.87	0.00	5.87
2.00	2.00	0.42	5.00	5.87	0.00	5.87
2.05	2.00	0.42	5.00	5.87	0.00	5.87
2.10	2.00	0.42	5.00	5.87	0.00	5.87
2.15	2.00	0.42	5.00	5.87	0.00	5.87
2.20	2.00	0.42	5.00	5.87	0.00	5.87
2.25	2.00	0.42	5.00	5.87	0.00	5.87
2.30	2.00	0.42	5.00	5.87	0.00	5.87
2.35	2.00	0.42	5.00	5.87	0.00	5.87

2.40	2.00	0.42	5.00	5.87	0.00	5.87
2.45	2.00	0.42	5.00	5.87	0.00	5.87
2.50	2.00	0.42	5.00	5.87	0.00	5.87
2.55	2.00	0.42	5.00	5.87	0.00	5.87
2.60	2.00	0.42	5.00	5.87	0.00	5.87
2.65	2.00	0.42	5.00	5.87	0.00	5.87
2.70	2.00	0.42	5.00	5.87	0.00	5.87
2.75	2.00	0.42	5.00	5.87	0.00	5.87
2.80	2.00	0.42	5.00	5.87	0.00	5.87
2.85	2.00	0.42	5.00	5.87	0.00	5.87
2.90	2.00	0.42	5.00	5.87	0.00	5.87
2.95	2.00	0.42	5.00	5.87	0.00	5.87
3.00	2.00	0.42	5.00	5.87	0.00	5.87
3.05	2.00	0.42	5.00	5.87	0.00	5.87
3.10	2.00	0.42	5.00	5.87	0.00	5.87
3.15	2.00	0.42	5.00	5.87	0.00	5.87
3.20	2.00	0.42	5.00	5.87	0.00	5.87
3.25	2.00	0.42	5.00	5.87	0.00	5.87
3.30	2.00	0.42	5.00	5.87	0.00	5.87
3.35	2.00	0.42	5.00	5.87	0.00	5.87
3.40	2.00	0.42	5.00	5.87	0.00	5.87
3.45	2.00	0.42	5.00	5.87	0.00	5.87
3.50	2.00	0.42	5.00	5.87	0.00	5.87
3.55	2.00	0.42	5.00	5.87	0.00	5.87
3.60	2.00	0.42	5.00	5.87	0.00	5.87
3.65	2.00	0.42	5.00	5.87	0.00	5.87
3.70	2.00	0.42	5.00	5.87	0.00	5.87
3.75	2.00	0.42	5.00	5.87	0.00	5.87
3.80	2.00	0.42	5.00	5.87	0.00	5.87
3.85	2.00	0.42	5.00	5.87	0.00	5.87
3.90	2.00	0.42	5.00	5.87	0.00	5.87
3.95	2.00	0.42	5.00	5.87	0.00	5.87
4.00	2.00	0.42	5.00	5.87	0.00	5.87
4.05	2.00	0.42	5.00	5.87	0.00	5.87
4.10	2.00	0.42	5.00	5.87	0.00	5.87
4.15	2.00	0.42	5.00	5.87	0.00	5.87
4.20	2.00	0.42	5.00	5.87	0.00	5.87
4.25	2.00	0.42	5.00	5.87	0.00	5.87
4.30	2.00	0.42	5.00	5.87	0.00	5.87
4.35	2.00	0.42	5.00	5.87	0.00	5.87
4.40	2.00	0.42	5.00	5.87	0.00	5.87
4.45	2.00	0.42	5.00	5.87	0.00	5.87
4.50	2.00	0.42	5.00	5.87	0.00	5.87
4.55	2.00	0.42	5.00	5.87	0.00	5.87
4.60	2.00	0.42	5.00	5.87	0.00	5.87
4.65	2.00	0.42	5.00	5.87	0.00	5.87
4.70	2.00	0.42	5.00	5.87	0.00	5.87
4.75	2.00	0.42	5.00	5.87	0.00	5.87
4.80	2.00	0.42	5.00	5.87	0.00	5.87
4.85	2.00	0.42	5.00	5.87	0.00	5.87

4.90	2.00	0.42	5.00	5.87	0.00	5.87
4.95	2.00	0.42	5.00	5.87	0.00	5.87
5.00	2.00	0.42	5.00	5.87	0.00	5.87
5.05	2.00	0.42	5.00	5.87	0.00	5.87
5.10	2.00	0.42	5.00	5.87	0.00	5.87
5.15	2.00	0.42	5.00	5.87	0.00	5.87
5.20	2.00	0.42	5.00	5.87	0.00	5.87
5.25	2.00	0.42	5.00	5.87	0.00	5.87
5.30	2.00	0.42	5.00	5.87	0.00	5.87
5.35	2.00	0.42	5.00	5.87	0.00	5.87
5.40	2.00	0.42	5.00	5.87	0.00	5.87
5.45	2.00	0.42	5.00	5.87	0.00	5.87
5.50	2.00	0.42	5.00	5.87	0.00	5.87
5.55	2.00	0.42	5.00	5.87	0.00	5.87
5.60	2.00	0.42	5.00	5.87	0.00	5.87
5.65	2.00	0.42	5.00	5.87	0.00	5.87
5.70	2.00	0.42	5.00	5.87	0.00	5.87
5.75	2.00	0.42	5.00	5.87	0.00	5.87
5.80	2.00	0.42	5.00	5.87	0.00	5.87
5.85	2.00	0.42	5.00	5.87	0.00	5.87
5.90	2.00	0.42	5.00	5.87	0.00	5.87
5.95	2.00	0.42	5.00	5.87	0.00	5.87
6.00	2.00	0.42	5.00	5.87	0.00	5.87
6.05	2.00	0.42	5.00	5.87	0.00	5.87
6.10	2.00	0.42	5.00	5.87	0.00	5.87
6.15	2.00	0.42	5.00	5.87	0.00	5.87
6.20	2.00	0.42	5.00	5.87	0.00	5.87
6.25	2.00	0.42	5.00	5.87	0.00	5.87
6.30	2.00	0.42	5.00	5.87	0.00	5.87
6.35	2.00	0.42	5.00	5.87	0.00	5.87
6.40	2.00	0.42	5.00	5.87	0.00	5.87
6.45	2.00	0.42	5.00	5.87	0.00	5.87
6.50	2.00	0.42	5.00	5.87	0.00	5.87
6.55	2.00	0.42	5.00	5.87	0.00	5.87
6.60	2.00	0.42	5.00	5.87	0.00	5.87
6.65	2.00	0.42	5.00	5.87	0.00	5.87
6.70	2.00	0.42	5.00	5.87	0.00	5.87
6.75	2.00	0.42	5.00	5.87	0.00	5.87
6.80	2.00	0.42	5.00	5.87	0.00	5.87
6.85	2.00	0.42	5.00	5.87	0.00	5.87
6.90	2.00	0.42	5.00	5.87	0.00	5.87
6.95	2.00	0.42	5.00	5.87	0.00	5.87
7.00	2.00	0.42	5.00	5.87	0.00	5.87
7.05	2.00	0.42	5.00	5.87	0.00	5.87
7.10	2.00	0.42	5.00	5.87	0.00	5.87
7.15	2.00	0.42	5.00	5.87	0.00	5.87
7.20	2.00	0.42	5.00	5.87	0.00	5.87
7.25	2.00	0.42	5.00	5.87	0.00	5.87
7.30	2.00	0.42	5.00	5.87	0.00	5.87
7.35	2.00	0.43	5.00	5.87	0.00	5.87

7.40	2.00	0.43	5.00	5.87	0.00	5.87
7.45	2.00	0.43	5.00	5.87	0.00	5.87
7.50	2.00	0.43	5.00	5.87	0.00	5.87
7.55	2.00	0.43	5.00	5.87	0.00	5.87
7.60	2.00	0.43	5.00	5.87	0.00	5.87
7.65	2.00	0.43	5.00	5.87	0.00	5.87
7.70	2.00	0.44	5.00	5.87	0.00	5.87
7.75	2.00	0.44	5.00	5.87	0.00	5.87
7.80	2.00	0.44	5.00	5.87	0.00	5.87
7.85	2.00	0.44	5.00	5.87	0.00	5.87
7.90	2.00	0.44	5.00	5.87	0.00	5.87
7.95	2.00	0.44	5.00	5.87	0.00	5.87
8.00	2.00	0.44	5.00	5.87	0.00	5.87
8.05	2.00	0.45	5.00	5.87	0.00	5.87
8.10	2.00	0.45	5.00	5.87	0.00	5.87
8.15	2.00	0.45	5.00	5.87	0.00	5.87
8.20	2.00	0.45	5.00	5.87	0.00	5.87
8.25	2.00	0.45	5.00	5.87	0.00	5.87
8.30	2.00	0.45	5.00	5.87	0.00	5.87
8.35	2.00	0.45	5.00	5.87	0.00	5.87
8.40	2.00	0.45	5.00	5.87	0.00	5.87
8.45	2.00	0.46	5.00	5.87	0.00	5.87
8.50	2.00	0.46	5.00	5.87	0.00	5.87
8.55	2.00	0.46	5.00	5.87	0.00	5.87
8.60	2.00	0.46	5.00	5.87	0.00	5.87
8.65	2.00	0.46	5.00	5.87	0.00	5.87
8.70	2.00	0.46	5.00	5.87	0.00	5.87
8.75	2.00	0.46	5.00	5.87	0.00	5.87
8.80	2.00	0.46	5.00	5.87	0.00	5.87
8.85	2.00	0.47	5.00	5.87	0.00	5.87
8.90	2.00	0.47	5.00	5.87	0.00	5.87
8.95	2.00	0.47	5.00	5.87	0.00	5.87
9.00	2.00	0.47	5.00	5.87	0.00	5.87
9.05	2.00	0.47	5.00	5.87	0.00	5.87
9.10	2.00	0.47	5.00	5.87	0.00	5.87
9.15	2.00	0.47	5.00	5.87	0.00	5.87
9.20	2.00	0.47	5.00	5.87	0.00	5.87
9.25	2.00	0.48	5.00	5.87	0.00	5.87
9.30	2.00	0.48	5.00	5.87	0.00	5.87
9.35	2.00	0.48	5.00	5.87	0.00	5.87
9.40	2.00	0.48	5.00	5.87	0.00	5.87
9.45	2.00	0.48	5.00	5.87	0.00	5.87
9.50	2.00	0.48	5.00	5.87	0.00	5.87
9.55	2.00	0.48	5.00	5.87	0.00	5.87
9.60	2.00	0.48	5.00	5.87	0.00	5.87
9.65	2.00	0.48	5.00	5.87	0.00	5.87
9.70	2.00	0.49	5.00	5.87	0.00	5.87
9.75	2.00	0.49	5.00	5.87	0.00	5.87
9.80	2.00	0.49	5.00	5.87	0.00	5.87
9.85	2.00	0.49	5.00	5.87	0.00	5.87

9.90	2.00	0.49	5.00	5.87	0.00	5.87
9.95	2.00	0.49	5.00	5.87	0.00	5.87
10.00	2.00	0.49	5.00	5.87	0.00	5.87
10.05	2.00	0.49	5.00	5.87	0.00	5.87
10.10	2.00	0.50	5.00	5.87	0.00	5.87
10.15	2.00	0.50	5.00	5.87	0.00	5.87
10.20	2.00	0.50	5.00	5.87	0.00	5.87
10.25	2.00	0.50	5.00	5.87	0.00	5.87
10.30	2.00	0.50	5.00	5.87	0.00	5.87
10.35	2.00	0.50	5.00	5.87	0.00	5.87
10.40	2.00	0.50	5.00	5.87	0.00	5.87
10.45	2.00	0.50	5.00	5.87	0.00	5.87
10.50	2.00	0.50	5.00	5.87	0.00	5.87
10.55	2.00	0.50	5.00	5.87	0.00	5.87
10.60	2.00	0.51	5.00	5.87	0.00	5.87
10.65	2.00	0.51	5.00	5.87	0.00	5.87
10.70	2.00	0.51	5.00	5.87	0.00	5.87
10.75	2.00	0.51	5.00	5.87	0.00	5.87
10.80	2.00	0.51	5.00	5.87	0.00	5.87
10.85	2.00	0.51	5.00	5.87	0.00	5.87
10.90	2.00	0.51	5.00	5.87	0.00	5.87
10.95	2.00	0.51	5.00	5.87	0.00	5.87
11.00	2.00	0.51	5.00	5.87	0.00	5.87
11.05	2.00	0.52	5.00	5.87	0.00	5.87
11.10	2.00	0.52	5.00	5.87	0.00	5.87
11.15	2.00	0.52	5.00	5.87	0.00	5.87
11.20	2.00	0.52	5.00	5.87	0.00	5.87
11.25	2.00	0.52	5.00	5.87	0.00	5.87
11.30	2.00	0.52	5.00	5.87	0.00	5.87
11.35	2.00	0.52	5.00	5.87	0.00	5.87
11.40	2.00	0.52	5.00	5.87	0.00	5.87
11.45	2.00	0.52	5.00	5.87	0.00	5.87
11.50	2.00	0.52	5.00	5.87	0.00	5.87
11.55	2.00	0.53	5.00	5.87	0.00	5.87
11.60	2.00	0.53	5.00	5.87	0.00	5.87
11.65	2.00	0.53	5.00	5.87	0.00	5.87
11.70	2.00	0.53	5.00	5.87	0.00	5.87
11.75	2.00	0.53	5.00	5.87	0.00	5.87
11.80	2.00	0.53	5.00	5.87	0.00	5.87
11.85	2.00	0.53	5.00	5.87	0.00	5.87
11.90	2.00	0.53	5.00	5.87	0.00	5.87
11.95	2.00	0.53	5.00	5.87	0.00	5.87
12.00	2.00	0.53	5.00	5.87	0.00	5.87
12.05	2.00	0.54	5.00	5.87	0.00	5.87
12.10	2.00	0.54	5.00	5.87	0.00	5.87
12.15	2.00	0.54	5.00	5.87	0.00	5.87
12.20	2.00	0.54	5.00	5.87	0.00	5.87
12.25	2.00	0.54	5.00	5.87	0.00	5.87
12.30	2.00	0.54	5.00	5.87	0.00	5.87
12.35	2.00	0.54	5.00	5.87	0.00	5.87

12.40	2.00	0.54	5.00	5.87	0.00	5.87
12.45	2.00	0.54	5.00	5.87	0.00	5.87
12.50	2.00	0.54	5.00	5.87	0.00	5.87
12.55	2.00	0.54	5.00	5.87	0.00	5.87
12.60	2.00	0.55	5.00	5.87	0.00	5.87
12.65	2.00	0.55	5.00	5.87	0.00	5.87
12.70	2.00	0.55	5.00	5.87	0.00	5.87
12.75	2.00	0.55	5.00	5.87	0.00	5.87
12.80	2.00	0.55	5.00	5.87	0.00	5.87
12.85	2.00	0.55	5.00	5.87	0.00	5.87
12.90	2.00	0.55	5.00	5.87	0.00	5.87
12.95	2.00	0.55	5.00	5.87	0.00	5.87
13.00	2.00	0.55	5.00	5.87	0.00	5.87
13.05	2.00	0.55	5.00	5.87	0.00	5.87
13.10	2.00	0.55	5.00	5.87	0.00	5.87
13.15	2.00	0.56	5.00	5.87	0.00	5.87
13.20	2.00	0.56	5.00	5.87	0.00	5.87
13.25	2.00	0.56	5.00	5.87	0.00	5.87
13.30	2.00	0.56	5.00	5.87	0.00	5.87
13.35	2.00	0.56	5.00	5.87	0.00	5.87
13.40	2.00	0.56	5.00	5.87	0.00	5.87
13.45	2.00	0.56	5.00	5.87	0.00	5.87
13.50	2.00	0.56	5.00	5.87	0.00	5.87
13.55	2.00	0.56	5.00	5.87	0.00	5.87
13.60	2.00	0.56	5.00	5.87	0.00	5.87
13.65	2.00	0.56	5.00	5.87	0.00	5.87
13.70	2.00	0.56	5.00	5.87	0.00	5.87
13.75	2.00	0.57	5.00	5.87	0.00	5.87
13.80	2.00	0.57	5.00	5.87	0.00	5.87
13.85	2.00	0.57	5.00	5.87	0.00	5.87
13.90	2.00	0.57	5.00	5.87	0.00	5.87
13.95	2.00	0.57	5.00	5.87	0.00	5.87
14.00	2.00	0.57	5.00	5.87	0.00	5.87
14.05	2.00	0.57	5.00	5.87	0.00	5.87
14.10	2.00	0.57	5.00	5.87	0.00	5.87
14.15	2.00	0.57	5.00	5.87	0.00	5.87
14.20	2.00	0.57	5.00	5.87	0.00	5.87
14.25	2.00	0.57	5.00	5.87	0.00	5.87
14.30	2.00	0.57	5.00	5.87	0.00	5.87
14.35	2.00	0.58	5.00	5.87	0.00	5.87
14.40	2.00	0.58	5.00	5.87	0.00	5.87
14.45	2.00	0.58	5.00	5.87	0.00	5.87
14.50	2.00	0.58	5.00	5.87	0.00	5.87
14.55	2.00	0.58	5.00	5.87	0.00	5.87
14.60	2.00	0.58	5.00	5.87	0.00	5.87
14.65	2.00	0.58	5.00	5.87	0.00	5.87
14.70	2.00	0.58	5.00	5.87	0.00	5.87
14.75	2.00	0.58	5.00	5.87	0.00	5.87
14.80	2.00	0.58	5.00	5.87	0.00	5.87
14.85	2.00	0.58	5.00	5.87	0.00	5.87

14.90	2.00	0.58	5.00	5.87	0.00	5.87
14.95	2.00	0.58	5.00	5.87	0.00	5.87
15.00	2.00	0.59	5.00	5.87	0.00	5.87
15.05	2.00	0.59	5.00	5.87	0.00	5.87
15.10	2.00	0.59	5.00	5.87	0.00	5.87
15.15	2.00	0.59	5.00	5.87	0.00	5.87
15.20	2.00	0.59	5.00	5.87	0.00	5.87
15.25	2.00	0.59	5.00	5.87	0.00	5.87
15.30	2.00	0.59	5.00	5.87	0.00	5.87
15.35	2.00	0.59	5.00	5.87	0.00	5.87
15.40	2.00	0.59	5.00	5.87	0.00	5.87
15.45	2.00	0.59	5.00	5.87	0.00	5.87
15.50	2.00	0.59	5.00	5.87	0.00	5.87
15.55	2.00	0.59	5.00	5.87	0.00	5.87
15.60	2.00	0.59	5.00	5.87	0.00	5.87
15.65	2.00	0.59	5.00	5.87	0.00	5.87
15.70	2.00	0.60	5.00	5.87	0.00	5.87
15.75	2.00	0.60	5.00	5.87	0.00	5.87
15.80	2.00	0.60	5.00	5.87	0.00	5.87
15.85	2.00	0.60	5.00	5.87	0.00	5.87
15.90	2.00	0.60	5.00	5.87	0.00	5.87
15.95	2.00	0.60	5.00	5.87	0.00	5.87
16.00	2.00	0.60	5.00	5.87	0.00	5.87
16.05	2.00	0.60	5.00	5.87	0.00	5.87
16.10	2.00	0.60	5.00	5.87	0.00	5.87
16.15	2.00	0.60	5.00	5.87	0.00	5.87
16.20	2.00	0.60	5.00	5.87	0.00	5.87
16.25	2.00	0.60	5.00	5.87	0.00	5.87
16.30	2.00	0.60	5.00	5.87	0.00	5.87
16.35	2.00	0.60	5.00	5.87	0.00	5.87
16.40	2.00	0.60	5.00	5.87	0.00	5.87
16.45	2.00	0.61	5.00	5.87	0.00	5.87
16.50	2.00	0.61	5.00	5.87	0.00	5.87
16.55	2.00	0.61	5.00	5.87	0.00	5.87
16.60	2.00	0.61	5.00	5.87	0.00	5.87
16.65	2.00	0.61	5.00	5.87	0.00	5.87
16.70	2.00	0.61	5.00	5.87	0.00	5.87
16.75	2.00	0.61	5.00	5.87	0.00	5.87
16.80	2.00	0.61	5.00	5.87	0.00	5.87
16.85	2.00	0.61	5.00	5.87	0.00	5.87
16.90	2.00	0.61	5.00	5.87	0.00	5.87
16.95	2.00	0.61	5.00	5.87	0.00	5.87
17.00	2.00	0.61	5.00	5.87	0.00	5.87
17.05	2.00	0.61	5.00	5.87	0.00	5.87
17.10	2.00	0.61	5.00	5.87	0.00	5.87
17.15	2.00	0.61	5.00	5.87	0.00	5.87
17.20	2.00	0.61	5.00	5.87	0.00	5.87
17.25	2.00	0.61	5.00	5.87	0.00	5.87
17.30	2.00	0.61	5.00	5.87	0.00	5.87
17.35	2.00	0.62	5.00	5.87	0.00	5.87

17.40	2.00	0.62	5.00	5.87	0.00	5.87
17.45	2.00	0.62	5.00	5.87	0.00	5.87
17.50	2.00	0.62	5.00	5.87	0.00	5.87
17.55	2.00	0.62	5.00	5.87	0.00	5.87
17.60	2.00	0.62	5.00	5.87	0.00	5.87
17.65	2.00	0.62	5.00	5.87	0.00	5.87
17.70	2.00	0.62	5.00	5.87	0.00	5.87
17.75	2.00	0.62	5.00	5.87	0.00	5.87
17.80	2.00	0.62	5.00	5.87	0.00	5.87
17.85	2.00	0.62	5.00	5.87	0.00	5.87
17.90	2.00	0.62	5.00	5.87	0.00	5.87
17.95	2.00	0.62	5.00	5.87	0.00	5.87
18.00	2.00	0.62	5.00	5.87	0.00	5.87
18.05	2.00	0.62	5.00	5.87	0.00	5.87
18.10	2.00	0.62	5.00	5.87	0.00	5.87
18.15	2.00	0.62	5.00	5.87	0.00	5.87
18.20	2.00	0.62	5.00	5.87	0.00	5.87
18.25	2.00	0.62	5.00	5.87	0.00	5.87
18.30	2.00	0.62	5.00	5.87	0.00	5.87
18.35	2.00	0.63	5.00	5.87	0.00	5.87
18.40	2.00	0.63	5.00	5.87	0.00	5.87
18.45	2.00	0.63	5.00	5.87	0.00	5.87
18.50	2.00	0.63	5.00	5.87	0.00	5.87
18.55	2.00	0.63	5.00	5.87	0.00	5.87
18.60	2.00	0.63	5.00	5.87	0.00	5.87
18.65	2.00	0.63	5.00	5.87	0.00	5.87
18.70	2.00	0.63	5.00	5.87	0.00	5.87
18.75	2.00	0.63	5.00	5.87	0.00	5.87
18.80	2.00	0.63	5.00	5.87	0.00	5.87
18.85	2.00	0.63	5.00	5.87	0.00	5.87
18.90	2.00	0.63	5.00	5.87	0.00	5.87
18.95	2.00	0.63	5.00	5.87	0.00	5.87
19.00	2.00	0.63	5.00	5.87	0.00	5.87
19.05	2.00	0.63	5.00	5.87	0.00	5.87
19.10	2.00	0.63	5.00	5.87	0.00	5.87
19.15	2.00	0.63	5.00	5.87	0.00	5.87
19.20	2.00	0.63	5.00	5.87	0.00	5.87
19.25	2.00	0.63	5.00	5.87	0.00	5.87
19.30	2.00	0.63	5.00	5.87	0.00	5.87
19.35	2.00	0.63	5.00	5.87	0.00	5.87
19.40	2.00	0.63	5.00	5.87	0.00	5.87
19.45	2.00	0.63	5.00	5.87	0.00	5.87
19.50	2.00	0.63	5.00	5.87	0.00	5.87
19.55	2.00	0.63	5.00	5.87	0.00	5.87
19.60	2.00	0.63	5.00	5.87	0.00	5.87
19.65	2.00	0.64	5.00	5.87	0.00	5.87
19.70	2.00	0.64	5.00	5.87	0.00	5.87
19.75	2.00	0.64	5.00	5.87	0.00	5.87
19.80	2.00	0.64	5.00	5.87	0.00	5.87
19.85	2.00	0.64	5.00	5.87	0.00	5.87

19.90	2.00	0.64	5.00	5.87	0.00	5.87
19.95	2.00	0.64	5.00	5.87	0.00	5.87
20.00	2.00	0.64	5.00	5.87	0.00	5.87
20.05	2.00	0.64	5.00	5.87	0.00	5.87
20.10	2.00	0.64	5.00	5.87	0.00	5.87
20.15	2.00	0.64	5.00	5.87	0.00	5.87
20.20	2.00	0.64	5.00	5.87	0.00	5.87
20.25	2.00	0.64	5.00	5.87	0.00	5.87
20.30	2.00	0.64	5.00	5.87	0.00	5.87
20.35	2.00	0.64	5.00	5.87	0.00	5.87
20.40	2.00	0.64	5.00	5.87	0.00	5.87
20.45	2.00	0.64	5.00	5.87	0.00	5.87
20.50	2.00	0.64	5.00	5.87	0.00	5.87
20.55	2.00	0.64	5.00	5.87	0.00	5.87
20.60	2.00	0.64	5.00	5.87	0.00	5.87
20.65	2.00	0.64	5.00	5.87	0.00	5.87
20.70	2.00	0.64	5.00	5.87	0.00	5.87
20.75	2.00	0.64	5.00	5.87	0.00	5.87
20.80	2.00	0.64	5.00	5.87	0.00	5.87
20.85	2.00	0.64	5.00	5.87	0.00	5.87
20.90	2.00	0.64	5.00	5.87	0.00	5.87
20.95	2.00	0.64	5.00	5.87	0.00	5.87
21.00	2.00	0.64	5.00	5.87	0.00	5.87
21.05	2.00	0.64	5.00	5.87	0.00	5.87
21.10	2.00	0.64	5.00	5.87	0.00	5.87
21.15	2.00	0.64	5.00	5.87	0.00	5.87
21.20	2.00	0.64	5.00	5.87	0.00	5.87
21.25	2.00	0.64	5.00	5.87	0.00	5.87
21.30	2.00	0.65	5.00	5.87	0.00	5.87
21.35	2.00	0.65	5.00	5.87	0.00	5.87
21.40	2.00	0.65	5.00	5.87	0.00	5.87
21.45	2.00	0.65	5.00	5.87	0.00	5.87
21.50	2.00	0.65	5.00	5.87	0.00	5.87
21.55	2.00	0.65	5.00	5.87	0.00	5.87
21.60	2.00	0.65	5.00	5.87	0.00	5.87
21.65	2.00	0.65	5.00	5.87	0.00	5.87
21.70	2.00	0.65	5.00	5.87	0.00	5.87
21.75	2.00	0.65	5.00	5.87	0.00	5.87
21.80	2.00	0.65	5.00	5.87	0.00	5.87
21.85	2.00	0.65	5.00	5.87	0.00	5.87
21.90	2.00	0.65	5.00	5.87	0.00	5.87
21.95	2.00	0.65	5.00	5.87	0.00	5.87
22.00	2.00	0.65	5.00	5.87	0.00	5.87
22.05	2.00	0.65	5.00	5.87	0.00	5.87
22.10	2.00	0.65	5.00	5.87	0.00	5.87
22.15	2.00	0.65	5.00	5.87	0.00	5.87
22.20	2.00	0.65	5.00	5.87	0.00	5.87
22.25	2.00	0.65	5.00	5.87	0.00	5.87
22.30	2.00	0.65	5.00	5.87	0.00	5.87
22.35	2.00	0.65	5.00	5.87	0.00	5.87

22.40	2.00	0.65	5.00	5.87	0.00	5.87
22.45	2.00	0.65	5.00	5.87	0.00	5.87
22.50	2.00	0.65	5.00	5.87	0.00	5.87
22.55	2.00	0.65	5.00	5.87	0.00	5.87
22.60	2.00	0.65	5.00	5.87	0.00	5.87
22.65	2.00	0.65	5.00	5.87	0.00	5.87
22.70	2.00	0.65	5.00	5.87	0.00	5.87
22.75	2.00	0.65	5.00	5.87	0.00	5.87
22.80	2.00	0.65	5.00	5.87	0.00	5.87
22.85	2.00	0.65	5.00	5.87	0.00	5.87
22.90	2.00	0.65	5.00	5.87	0.00	5.87
22.95	2.00	0.65	5.00	5.87	0.00	5.87
23.00	2.00	0.65	5.00	5.87	0.00	5.87
23.05	2.00	0.65	5.00	5.87	0.00	5.87
23.10	2.00	0.65	5.00	5.87	0.00	5.87
23.15	2.00	0.65	5.00	5.87	0.00	5.87
23.20	2.00	0.65	5.00	5.87	0.00	5.87
23.25	2.00	0.66	5.00	5.87	0.00	5.87
23.30	2.00	0.66	5.00	5.87	0.00	5.87
23.35	2.00	0.66	5.00	5.87	0.00	5.87
23.40	2.00	0.66	5.00	5.87	0.00	5.87
23.45	2.00	0.66	5.00	5.87	0.00	5.87
23.50	2.00	0.66	5.00	5.87	0.00	5.87
23.55	2.00	0.66	5.00	5.87	0.00	5.87
23.60	2.00	0.66	5.00	5.87	0.00	5.87
23.65	2.00	0.66	5.00	5.87	0.00	5.87
23.70	2.00	0.66	5.00	5.87	0.00	5.87
23.75	2.00	0.66	5.00	5.87	0.00	5.87
23.80	2.00	0.66	5.00	5.87	0.00	5.87
23.85	2.00	0.66	5.00	5.87	0.00	5.87
23.90	2.00	0.66	5.00	5.87	0.00	5.87
23.95	2.00	0.66	5.00	5.87	0.00	5.87
24.00	2.00	0.66	5.00	5.87	0.00	5.87
24.05	2.00	0.66	5.00	5.87	0.00	5.87
24.10	2.00	0.66	5.00	5.87	0.00	5.87
24.15	2.00	0.66	5.00	5.87	0.00	5.87
24.20	2.00	0.66	5.00	5.87	0.00	5.87
24.25	2.00	0.66	5.00	5.87	0.00	5.87
24.30	2.00	0.66	5.00	5.87	0.00	5.87
24.35	2.00	0.66	5.00	5.87	0.00	5.87
24.40	2.00	0.66	5.00	5.87	0.00	5.87
24.45	2.00	0.66	5.00	5.87	0.00	5.87
24.50	2.00	0.66	5.00	5.87	0.00	5.87
24.55	2.00	0.66	5.00	5.87	0.00	5.87
24.60	2.00	0.66	5.00	5.87	0.00	5.87
24.65	2.00	0.66	5.00	5.87	0.00	5.87
24.70	2.00	0.66	5.00	5.87	0.00	5.87
24.75	2.00	0.66	5.00	5.87	0.00	5.87
24.80	2.00	0.66	5.00	5.87	0.00	5.87
24.85	2.00	0.66	5.00	5.87	0.00	5.87

24.90	2.00	0.66	5.00	5.87	0.00	5.87
24.95	2.00	0.66	5.00	5.87	0.00	5.87
25.00	2.00	0.66	5.00	5.87	0.00	5.87
25.05	2.00	0.66	5.00	5.87	0.00	5.87
25.10	2.00	0.66	5.00	5.87	0.00	5.87
25.15	2.00	0.66	5.00	5.87	0.00	5.87
25.20	2.00	0.66	5.00	5.87	0.00	5.87
25.25	2.00	0.66	5.00	5.87	0.00	5.87
25.30	2.00	0.66	5.00	5.87	0.00	5.87
25.35	2.00	0.66	5.00	5.87	0.00	5.87
25.40	2.00	0.66	5.00	5.87	0.00	5.87
25.45	2.00	0.66	5.00	5.87	0.00	5.87
25.50	2.00	0.66	5.00	5.87	0.00	5.87
25.55	2.00	0.66	5.00	5.87	0.00	5.87
25.60	2.00	0.66	5.00	5.87	0.00	5.87
25.65	2.00	0.67	5.00	5.87	0.00	5.87
25.70	2.00	0.67	5.00	5.87	0.00	5.87
25.75	2.00	0.67	5.00	5.87	0.00	5.87
25.80	2.00	0.67	5.00	5.87	0.00	5.87
25.85	2.00	0.67	5.00	5.87	0.00	5.87
25.90	2.00	0.67	5.00	5.87	0.00	5.87
25.95	2.00	0.67	5.00	5.87	0.00	5.87
26.00	2.00	0.67	5.00	5.87	0.00	5.87
26.05	2.00	0.67	5.00	5.87	0.00	5.87
26.10	2.00	0.67	5.00	5.87	0.00	5.87
26.15	2.00	0.67	5.00	5.87	0.00	5.87
26.20	2.00	0.67	5.00	5.87	0.00	5.87
26.25	2.00	0.67	5.00	5.87	0.00	5.87
26.30	2.00	0.67	5.00	5.87	0.00	5.87
26.35	2.00	0.67	5.00	5.87	0.00	5.87
26.40	2.00	0.67	5.00	5.87	0.00	5.87
26.45	2.00	0.67	5.00	5.87	0.00	5.87
26.50	2.00	0.67	5.00	5.87	0.00	5.87
26.55	2.00	0.67	5.00	5.87	0.00	5.87
26.60	2.00	0.67	5.00	5.87	0.00	5.87
26.65	2.00	0.67	5.00	5.87	0.00	5.87
26.70	2.00	0.67	5.00	5.87	0.00	5.87
26.75	2.00	0.67	5.00	5.87	0.00	5.87
26.80	2.00	0.67	5.00	5.87	0.00	5.87
26.85	2.00	0.67	5.00	5.87	0.00	5.87
26.90	2.00	0.67	5.00	5.87	0.00	5.87
26.95	2.00	0.67	5.00	5.87	0.00	5.87
27.00	2.00	0.67	5.00	5.87	0.00	5.87
27.05	2.00	0.67	5.00	5.87	0.00	5.87
27.10	2.00	0.67	5.00	5.87	0.00	5.87
27.15	2.00	0.67	5.00	5.87	0.00	5.87
27.20	2.00	0.67	5.00	5.87	0.00	5.87
27.25	2.00	0.67	5.00	5.87	0.00	5.87
27.30	2.00	0.67	5.00	5.87	0.00	5.87
27.35	2.00	0.67	5.00	5.87	0.00	5.87

27.40	2.00	0.67	5.00	5.87	0.00	5.87
27.45	2.00	0.67	5.00	5.87	0.00	5.87
27.50	2.00	0.67	5.00	5.87	0.00	5.87
27.55	2.00	0.67	5.00	5.87	0.00	5.87
27.60	2.00	0.67	5.00	5.87	0.00	5.87
27.65	2.00	0.67	5.00	5.87	0.00	5.87
27.70	2.00	0.67	5.00	5.87	0.00	5.87
27.75	2.00	0.67	5.00	5.87	0.00	5.87
27.80	2.00	0.67	5.00	5.87	0.00	5.87
27.85	2.00	0.67	5.00	5.87	0.00	5.87
27.90	2.00	0.67	5.00	5.87	0.00	5.87
27.95	2.00	0.67	5.00	5.87	0.00	5.87
28.00	2.00	0.67	5.00	5.87	0.00	5.87
28.05	2.00	0.67	5.00	5.87	0.00	5.87
28.10	2.00	0.67	5.00	5.87	0.00	5.87
28.15	2.00	0.67	5.00	5.87	0.00	5.87
28.20	2.00	0.67	5.00	5.87	0.00	5.87
28.25	2.00	0.67	5.00	5.87	0.00	5.87
28.30	2.00	0.67	5.00	5.87	0.00	5.87
28.35	2.00	0.67	5.00	5.87	0.00	5.87
28.40	2.00	0.67	5.00	5.87	0.00	5.87
28.45	2.00	0.68	5.00	5.87	0.00	5.87
28.50	2.00	0.68	5.00	5.87	0.00	5.87
28.55	2.00	0.68	5.00	5.87	0.00	5.87
28.60	2.00	0.68	5.00	5.87	0.00	5.87
28.65	2.00	0.68	5.00	5.87	0.00	5.87
28.70	2.00	0.68	5.00	5.87	0.00	5.87
28.75	2.00	0.68	5.00	5.87	0.00	5.87
28.80	2.00	0.68	5.00	5.87	0.00	5.87
28.85	2.00	0.68	5.00	5.87	0.00	5.87
28.90	2.00	0.68	5.00	5.87	0.00	5.87
28.95	2.00	0.68	5.00	5.87	0.00	5.87
29.00	2.00	0.68	5.00	5.87	0.00	5.87
29.05	2.00	0.68	5.00	5.87	0.00	5.87
29.10	2.00	0.68	5.00	5.87	0.00	5.87
29.15	2.00	0.68	5.00	5.87	0.00	5.87
29.20	2.00	0.68	5.00	5.87	0.00	5.87
29.25	2.00	0.68	5.00	5.87	0.00	5.87
29.30	2.00	0.68	5.00	5.87	0.00	5.87
29.35	2.00	0.68	5.00	5.87	0.00	5.87
29.40	2.00	0.68	5.00	5.87	0.00	5.87
29.45	2.00	0.68	5.00	5.87	0.00	5.87
29.50	2.00	0.68	5.00	5.87	0.00	5.87
29.55	2.00	0.68	5.00	5.87	0.00	5.87
29.60	2.00	0.68	5.00	5.87	0.00	5.87
29.65	2.00	0.68	5.00	5.87	0.00	5.87
29.70	2.00	0.68	5.00	5.87	0.00	5.87
29.75	2.00	0.68	5.00	5.87	0.00	5.87
29.80	2.00	0.68	5.00	5.87	0.00	5.87
29.85	2.00	0.68	5.00	5.87	0.00	5.87

29.90	2.00	0.68	5.00	5.87	0.00	5.87
29.95	2.00	0.68	5.00	5.87	0.00	5.87
30.00	2.00	0.68	5.00	5.87	0.00	5.87
30.05	0.29	0.68	0.43*	5.87	0.00	5.87
30.10	0.29	0.68	0.43*	5.86	0.00	5.86
30.15	0.29	0.68	0.43*	5.85	0.00	5.85
30.20	0.30	0.68	0.43*	5.84	0.00	5.84
30.25	0.30	0.68	0.44*	5.83	0.00	5.83
30.30	0.30	0.68	0.44*	5.82	0.00	5.82
30.35	0.30	0.68	0.44*	5.80	0.00	5.80
30.40	0.30	0.68	0.44*	5.79	0.00	5.79
30.45	0.30	0.68	0.44*	5.78	0.00	5.78
30.50	0.30	0.68	0.44*	5.77	0.00	5.77
30.55	0.30	0.68	0.44*	5.76	0.00	5.76
30.60	0.30	0.68	0.44*	5.75	0.00	5.75
30.65	0.30	0.68	0.44*	5.73	0.00	5.73
30.70	0.30	0.68	0.44*	5.72	0.00	5.72
30.75	0.30	0.68	0.44*	5.71	0.00	5.71
30.80	0.30	0.68	0.45*	5.70	0.00	5.70
30.85	0.30	0.68	0.45*	5.69	0.00	5.69
30.90	0.30	0.68	0.45*	5.68	0.00	5.68
30.95	0.30	0.68	0.45*	5.66	0.00	5.66
31.00	0.30	0.68	0.45*	5.65	0.00	5.65
31.05	0.31	0.68	0.45*	5.64	0.00	5.64
31.10	0.31	0.68	0.45*	5.63	0.00	5.63
31.15	0.31	0.68	0.45*	5.62	0.00	5.62
31.20	0.31	0.68	0.45*	5.61	0.00	5.61
31.25	0.31	0.68	0.45*	5.60	0.00	5.60
31.30	0.31	0.68	0.46*	5.58	0.00	5.58
31.35	0.31	0.68	0.46*	5.57	0.00	5.57
31.40	0.31	0.68	0.46*	5.56	0.00	5.56
31.45	0.31	0.68	0.46*	5.55	0.00	5.55
31.50	0.31	0.68	0.46*	5.54	0.00	5.54
31.55	0.31	0.68	0.46*	5.53	0.00	5.53
31.60	0.31	0.68	0.46*	5.52	0.00	5.52
31.65	0.31	0.68	0.46*	5.51	0.00	5.51
31.70	0.31	0.68	0.46*	5.49	0.00	5.49
31.75	0.31	0.68	0.46*	5.48	0.00	5.48
31.80	0.31	0.68	0.46*	5.47	0.00	5.47
31.85	0.32	0.68	0.47*	5.46	0.00	5.46
31.90	0.32	0.68	0.47*	5.45	0.00	5.45
31.95	0.32	0.68	0.47*	5.44	0.00	5.44
32.00	0.32	0.68	0.47*	5.43	0.00	5.43
32.05	0.32	0.68	0.47*	5.42	0.00	5.42
32.10	0.32	0.68	0.47*	5.41	0.00	5.41
32.15	0.32	0.68	0.47*	5.39	0.00	5.39
32.20	0.32	0.68	0.47*	5.38	0.00	5.38
32.25	0.32	0.68	0.47*	5.37	0.00	5.37
32.30	0.32	0.68	0.47*	5.36	0.00	5.36
32.35	0.32	0.68	0.48*	5.35	0.00	5.35

32.40	0.32	0.68	0.48*	5.34	0.00	5.34
32.45	0.32	0.68	0.48*	5.33	0.00	5.33
32.50	0.32	0.68	0.48*	5.32	0.00	5.32
32.55	0.32	0.68	0.48*	5.31	0.00	5.31
32.60	0.32	0.68	0.48*	5.30	0.00	5.30
32.65	0.33	0.67	0.48*	5.28	0.00	5.28
32.70	0.33	0.67	0.48*	5.27	0.00	5.27
32.75	0.33	0.67	0.48*	5.26	0.00	5.26
32.80	0.33	0.67	0.49*	5.25	0.00	5.25
32.85	0.33	0.67	0.48*	5.24	0.00	5.24
32.90	0.33	0.67	0.48*	5.23	0.00	5.23
32.95	0.33	0.67	0.48*	5.22	0.00	5.22
33.00	0.33	0.67	0.48*	5.21	0.00	5.21
33.05	0.33	0.67	0.48*	5.20	0.00	5.20
33.10	0.33	0.67	0.48*	5.19	0.00	5.19
33.15	0.33	0.67	0.48*	5.18	0.00	5.18
33.20	0.33	0.67	0.48*	5.16	0.00	5.16
33.25	0.33	0.67	0.48*	5.15	0.00	5.15
33.30	0.33	0.67	0.48*	5.14	0.00	5.14
33.35	0.33	0.67	0.48*	5.13	0.00	5.13
33.40	0.33	0.67	0.48*	5.12	0.00	5.12
33.45	0.33	0.67	0.48*	5.11	0.00	5.11
33.50	0.32	0.67	0.48*	5.10	0.00	5.10
33.55	0.32	0.67	0.48*	5.09	0.00	5.09
33.60	0.32	0.67	0.48*	5.08	0.00	5.08
33.65	0.32	0.67	0.48*	5.07	0.00	5.07
33.70	0.32	0.67	0.48*	5.06	0.00	5.06
33.75	0.32	0.67	0.48*	5.05	0.00	5.05
33.80	0.32	0.67	0.48*	5.03	0.00	5.03
33.85	0.32	0.67	0.48*	5.02	0.00	5.02
33.90	0.32	0.67	0.48*	5.01	0.00	5.01
33.95	0.32	0.67	0.48*	5.00	0.00	5.00
34.00	0.32	0.67	0.48*	4.99	0.00	4.99
34.05	0.32	0.67	0.48*	4.98	0.00	4.98
34.10	0.32	0.67	0.48*	4.97	0.00	4.97
34.15	0.32	0.67	0.48*	4.96	0.00	4.96
34.20	0.32	0.67	0.48*	4.95	0.00	4.95
34.25	0.32	0.67	0.48*	4.94	0.00	4.94
34.30	0.32	0.67	0.48*	4.92	0.00	4.92
34.35	0.32	0.67	0.48*	4.91	0.00	4.91
34.40	0.32	0.67	0.48*	4.90	0.00	4.90
34.45	0.32	0.67	0.48*	4.89	0.00	4.89
34.50	0.32	0.67	0.48*	4.88	0.00	4.88
34.55	0.32	0.67	0.48*	4.87	0.00	4.87
34.60	0.32	0.67	0.48*	4.86	0.00	4.86
34.65	0.32	0.67	0.48*	4.85	0.00	4.85
34.70	0.32	0.67	0.48*	4.84	0.00	4.84
34.75	0.32	0.67	0.48*	4.83	0.00	4.83
34.80	0.32	0.67	0.48*	4.81	0.00	4.81
34.85	0.32	0.67	0.48*	4.80	0.00	4.80

34.90	0.32	0.67	0.48*	4.79	0.00	4.79
34.95	0.32	0.67	0.48*	4.78	0.00	4.78
35.00	0.32	0.67	0.48*	4.77	0.00	4.77
35.05	0.32	0.67	0.47*	4.76	0.00	4.76
35.10	0.32	0.67	0.47*	4.75	0.00	4.75
35.15	0.32	0.67	0.47*	4.74	0.00	4.74
35.20	0.32	0.67	0.47*	4.73	0.00	4.73
35.25	0.32	0.67	0.47*	4.71	0.00	4.71
35.30	0.32	0.67	0.47*	4.70	0.00	4.70
35.35	0.31	0.67	0.47*	4.69	0.00	4.69
35.40	0.31	0.67	0.47*	4.68	0.00	4.68
35.45	0.31	0.67	0.47*	4.67	0.00	4.67
35.50	0.31	0.67	0.47*	4.66	0.00	4.66
35.55	0.31	0.67	0.47*	4.65	0.00	4.65
35.60	0.31	0.67	0.47*	4.64	0.00	4.64
35.65	0.31	0.67	0.47*	4.63	0.00	4.63
35.70	0.31	0.67	0.47*	4.61	0.00	4.61
35.75	0.31	0.67	0.47*	4.60	0.00	4.60
35.80	0.31	0.67	0.47*	4.59	0.00	4.59
35.85	0.31	0.67	0.47*	4.58	0.00	4.58
35.90	0.31	0.67	0.47*	4.57	0.00	4.57
35.95	0.31	0.67	0.47*	4.56	0.00	4.56
36.00	0.31	0.67	0.46*	4.55	0.00	4.55
36.05	0.31	0.66	0.46*	4.54	0.00	4.54
36.10	0.31	0.66	0.46*	4.52	0.00	4.52
36.15	0.31	0.66	0.46*	4.51	0.00	4.51
36.20	0.31	0.66	0.46*	4.50	0.00	4.50
36.25	0.31	0.66	0.46*	4.49	0.00	4.49
36.30	0.31	0.66	0.46*	4.48	0.00	4.48
36.35	0.31	0.66	0.46*	4.47	0.00	4.47
36.40	0.30	0.66	0.46*	4.46	0.00	4.46
36.45	0.30	0.66	0.46*	4.44	0.00	4.44
36.50	0.30	0.66	0.46*	4.43	0.00	4.43
36.55	0.30	0.66	0.46*	4.42	0.00	4.42
36.60	0.30	0.66	0.46*	4.41	0.00	4.41
36.65	0.30	0.66	0.45*	4.40	0.00	4.40
36.70	0.30	0.66	0.45*	4.39	0.00	4.39
36.75	0.30	0.66	0.45*	4.37	0.00	4.37
36.80	0.30	0.66	0.45*	4.36	0.00	4.36
36.85	0.30	0.66	0.45*	4.35	0.00	4.35
36.90	0.30	0.66	0.45*	4.34	0.00	4.34
36.95	0.30	0.66	0.45*	4.33	0.00	4.33
37.00	0.30	0.66	0.45*	4.32	0.00	4.32
37.05	0.30	0.66	0.45*	4.30	0.00	4.30
37.10	0.29	0.66	0.45*	4.29	0.00	4.29
37.15	0.29	0.66	0.45*	4.28	0.00	4.28
37.20	0.29	0.66	0.44*	4.27	0.00	4.27
37.25	0.29	0.66	0.44*	4.26	0.00	4.26
37.30	0.29	0.66	0.44*	4.25	0.00	4.25
37.35	0.29	0.66	0.44*	4.23	0.00	4.23

37.40	0.29	0.66	0.44*	4.22	0.00	4.22
37.45	0.29	0.66	0.44*	4.21	0.00	4.21
37.50	0.29	0.66	0.44*	4.20	0.00	4.20
37.55	0.29	0.66	0.44*	4.19	0.00	4.19
37.60	0.29	0.66	0.43*	4.17	0.00	4.17
37.65	0.29	0.66	0.43*	4.16	0.00	4.16
37.70	0.28	0.66	0.43*	4.15	0.00	4.15
37.75	0.28	0.66	0.43*	4.14	0.00	4.14
37.80	0.28	0.66	0.43*	4.13	0.00	4.13
37.85	0.28	0.66	0.43*	4.11	0.00	4.11
37.90	0.28	0.66	0.43*	4.10	0.00	4.10
37.95	0.28	0.66	0.43*	4.09	0.00	4.09
38.00	0.28	0.66	0.42*	4.08	0.00	4.08
38.05	0.28	0.66	0.42*	4.06	0.00	4.06
38.10	0.28	0.66	0.42*	4.05	0.00	4.05
38.15	0.28	0.66	0.42*	4.04	0.00	4.04
38.20	0.27	0.66	0.42*	4.03	0.00	4.03
38.25	0.27	0.66	0.42*	4.01	0.00	4.01
38.30	0.27	0.66	0.42*	4.00	0.00	4.00
38.35	0.27	0.66	0.41*	3.99	0.00	3.99
38.40	0.27	0.66	0.41*	3.98	0.00	3.98
38.45	0.27	0.66	0.41*	3.96	0.00	3.96
38.50	0.27	0.66	0.41*	3.95	0.00	3.95
38.55	0.27	0.66	0.41*	3.94	0.00	3.94
38.60	0.27	0.65	0.41*	3.93	0.00	3.93
38.65	0.27	0.65	0.41*	3.91	0.00	3.91
38.70	0.27	0.65	0.41*	3.90	0.00	3.90
38.75	0.26	0.65	0.40*	3.89	0.00	3.89
38.80	0.26	0.65	0.40*	3.88	0.00	3.88
38.85	0.26	0.65	0.40*	3.86	0.00	3.86
38.90	0.26	0.65	0.40*	3.85	0.00	3.85
38.95	0.26	0.65	0.40*	3.84	0.00	3.84
39.00	0.26	0.65	0.40*	3.82	0.00	3.82
39.05	0.26	0.65	0.40*	3.81	0.00	3.81
39.10	0.26	0.65	0.40*	3.80	0.00	3.80
39.15	0.26	0.65	0.40*	3.78	0.00	3.78
39.20	0.26	0.65	0.40*	3.77	0.00	3.77
39.25	0.26	0.65	0.40*	3.76	0.00	3.76
39.30	0.26	0.65	0.40*	3.75	0.00	3.75
39.35	0.26	0.65	0.40*	3.73	0.00	3.73
39.40	0.26	0.65	0.40*	3.72	0.00	3.72
39.45	0.26	0.65	0.40*	3.71	0.00	3.71
39.50	0.26	0.65	0.40*	3.69	0.00	3.69
39.55	0.26	0.65	0.40*	3.68	0.00	3.68
39.60	0.26	0.65	0.40*	3.67	0.00	3.67
39.65	0.26	0.65	0.40*	3.65	0.00	3.65
39.70	0.26	0.65	0.40*	3.64	0.00	3.64
39.75	0.26	0.65	0.40*	3.63	0.00	3.63
39.80	0.26	0.65	0.40*	3.62	0.00	3.62
39.85	0.26	0.65	0.40*	3.60	0.00	3.60

39.90	0.26	0.65	0.40*	3.59	0.00	3.59
39.95	0.26	0.65	0.40*	3.58	0.00	3.58
40.00	0.26	0.65	0.40*	3.56	0.00	3.56
40.05	0.26	0.65	0.40*	3.55	0.00	3.55
40.10	0.26	0.65	0.39*	3.54	0.00	3.54
40.15	0.25	0.65	0.39*	3.52	0.00	3.52
40.20	0.25	0.65	0.39*	3.51	0.00	3.51
40.25	0.25	0.65	0.39*	3.50	0.00	3.50
40.30	0.25	0.65	0.39*	3.48	0.00	3.48
40.35	0.25	0.65	0.39*	3.47	0.00	3.47
40.40	0.25	0.65	0.38*	3.46	0.00	3.46
40.45	0.25	0.65	0.38*	3.44	0.00	3.44
40.50	0.25	0.65	0.38*	3.43	0.00	3.43
40.55	0.24	0.65	0.38*	3.42	0.00	3.42
40.60	0.24	0.65	0.38*	3.40	0.00	3.40
40.65	0.24	0.65	0.37*	3.39	0.00	3.39
40.70	0.24	0.65	0.37*	3.38	0.00	3.38
40.75	0.24	0.65	0.37*	3.36	0.00	3.36
40.80	0.24	0.65	0.37*	3.35	0.00	3.35
40.85	0.24	0.64	0.37*	3.33	0.00	3.33
40.90	0.23	0.64	0.36*	3.32	0.00	3.32
40.95	0.23	0.64	0.36*	3.31	0.00	3.31
41.00	0.23	0.64	0.36*	3.29	0.00	3.29
41.05	0.23	0.64	0.36*	3.28	0.00	3.28
41.10	0.23	0.64	0.36*	3.26	0.00	3.26
41.15	0.23	0.64	0.36*	3.25	0.00	3.25
41.20	0.23	0.64	0.35*	3.23	0.00	3.23
41.25	0.23	0.64	0.35*	3.22	0.00	3.22
41.30	0.23	0.64	0.35*	3.21	0.00	3.21
41.35	0.22	0.64	0.35*	3.19	0.00	3.19
41.40	0.22	0.64	0.35*	3.18	0.00	3.18
41.45	0.22	0.64	0.34*	3.16	0.00	3.16
41.50	0.22	0.64	0.34*	3.15	0.00	3.15
41.55	0.22	0.64	0.34*	3.13	0.00	3.13
41.60	0.22	0.64	0.34*	3.12	0.00	3.12
41.65	0.22	0.64	0.34*	3.10	0.00	3.10
41.70	0.22	0.64	0.34*	3.09	0.00	3.09
41.75	0.21	0.64	0.33*	3.07	0.00	3.07
41.80	0.21	0.64	0.33*	3.06	0.00	3.06
41.85	0.21	0.64	0.33*	3.04	0.00	3.04
41.90	0.21	0.64	0.33*	3.03	0.00	3.03
41.95	0.21	0.64	0.33*	3.01	0.00	3.01
42.00	0.21	0.64	0.33*	2.99	0.00	2.99
42.05	0.21	0.64	0.32*	2.98	0.00	2.98
42.10	0.21	0.64	0.32*	2.96	0.00	2.96
42.15	0.21	0.64	0.32*	2.95	0.00	2.95
42.20	0.20	0.64	0.32*	2.93	0.00	2.93
42.25	0.20	0.64	0.32*	2.92	0.00	2.92
42.30	0.20	0.64	0.32*	2.90	0.00	2.90
42.35	0.20	0.64	0.32*	2.88	0.00	2.88

42.40	0.20	0.64	0.31*	2.87	0.00	2.87
42.45	0.20	0.64	0.31*	2.85	0.00	2.85
42.50	0.20	0.64	0.31*	2.84	0.00	2.84
42.55	0.20	0.64	0.31*	2.82	0.00	2.82
42.60	0.20	0.64	0.31*	2.80	0.00	2.80
42.65	0.19	0.64	0.31*	2.79	0.00	2.79
42.70	0.19	0.64	0.30*	2.77	0.00	2.77
42.75	0.19	0.64	0.30*	2.76	0.00	2.76
42.80	0.19	0.64	0.30*	2.74	0.00	2.74
42.85	0.19	0.64	0.30*	2.72	0.00	2.72
42.90	0.19	0.64	0.30*	2.71	0.00	2.71
42.95	0.19	0.64	0.30*	2.69	0.00	2.69
43.00	0.19	0.64	0.29*	2.67	0.00	2.67
43.05	0.19	0.63	0.29*	2.66	0.00	2.66
43.10	0.19	0.63	0.29*	2.64	0.00	2.64
43.15	0.18	0.63	0.29*	2.62	0.00	2.62
43.20	0.18	0.63	0.29*	2.61	0.00	2.61
43.25	0.18	0.63	0.29*	2.59	0.00	2.59
43.30	0.18	0.63	0.29*	2.57	0.00	2.57
43.35	0.18	0.63	0.28*	2.55	0.00	2.55
43.40	0.18	0.63	0.28*	2.54	0.00	2.54
43.45	0.18	0.63	0.28*	2.52	0.00	2.52
43.50	0.18	0.63	0.28*	2.50	0.00	2.50
43.55	0.18	0.63	0.28*	2.49	0.00	2.49
43.60	0.18	0.63	0.28*	2.47	0.00	2.47
43.65	0.17	0.63	0.28*	2.45	0.00	2.45
43.70	0.17	0.63	0.27*	2.43	0.00	2.43
43.75	0.17	0.63	0.27*	2.42	0.00	2.42
43.80	0.17	0.63	0.27*	2.40	0.00	2.40
43.85	0.17	0.63	0.27*	2.38	0.00	2.38
43.90	0.17	0.63	0.27*	2.36	0.00	2.36
43.95	0.17	0.63	0.27*	2.34	0.00	2.34
44.00	0.17	0.63	0.27*	2.33	0.00	2.33
44.05	0.17	0.63	0.26*	2.31	0.00	2.31
44.10	0.17	0.63	0.26*	2.29	0.00	2.29
44.15	0.17	0.63	0.26*	2.27	0.00	2.27
44.20	0.16	0.63	0.26*	2.25	0.00	2.25
44.25	0.16	0.63	0.26*	2.24	0.00	2.24
44.30	0.16	0.63	0.26*	2.22	0.00	2.22
44.35	0.16	0.63	0.26*	2.20	0.00	2.20
44.40	0.16	0.63	0.26*	2.18	0.00	2.18
44.45	0.16	0.63	0.25*	2.16	0.00	2.16
44.50	0.16	0.63	0.25*	2.14	0.00	2.14
44.55	0.16	0.63	0.25*	2.12	0.00	2.12
44.60	0.16	0.63	0.25*	2.11	0.00	2.11
44.65	0.16	0.63	0.25*	2.09	0.00	2.09
44.70	0.16	0.63	0.25*	2.07	0.00	2.07
44.75	0.15	0.63	0.25*	2.05	0.00	2.05
44.80	0.15	0.63	0.24*	2.03	0.00	2.03
44.85	0.15	0.63	0.24*	2.01	0.00	2.01

44.90	0.15	0.63	0.24*	1.99	0.00	1.99
44.95	0.15	0.63	0.24*	1.97	0.00	1.97
45.00	0.15	0.63	0.24*	1.95	0.00	1.95
45.05	0.15	0.63	0.24*	1.93	0.00	1.93
45.10	0.15	0.63	0.24*	1.92	0.00	1.92
45.15	0.15	0.63	0.24*	1.90	0.00	1.90
45.20	0.15	0.62	0.24*	1.88	0.00	1.88
45.25	0.15	0.62	0.24*	1.86	0.00	1.86
45.30	0.15	0.62	0.24*	1.84	0.00	1.84
45.35	0.15	0.62	0.24*	1.82	0.00	1.82
45.40	0.15	0.62	0.24*	1.80	0.00	1.80
45.45	0.15	0.62	0.24*	1.78	0.00	1.78
45.50	0.15	0.62	0.24*	1.76	0.00	1.76
45.55	0.15	0.62	0.24*	1.74	0.00	1.74
45.60	0.15	0.62	0.24*	1.72	0.00	1.72
45.65	0.15	0.62	0.24*	1.70	0.00	1.70
45.70	0.15	0.62	0.24*	1.68	0.00	1.68
45.75	0.15	0.62	0.24*	1.66	0.00	1.66
45.80	0.15	0.62	0.24*	1.64	0.00	1.64
45.85	0.15	0.62	0.24*	1.63	0.00	1.63
45.90	0.15	0.62	0.24*	1.61	0.00	1.61
45.95	0.15	0.62	0.24*	1.59	0.00	1.59
46.00	0.15	0.62	0.24*	1.57	0.00	1.57
46.05	0.15	0.62	0.24*	1.55	0.00	1.55
46.10	0.15	0.62	0.24*	1.53	0.00	1.53
46.15	0.15	0.62	0.24*	1.51	0.00	1.51
46.20	0.15	0.62	0.24*	1.49	0.00	1.49
46.25	0.15	0.62	0.24*	1.47	0.00	1.47
46.30	0.15	0.62	0.24*	1.45	0.00	1.45
46.35	0.15	0.62	0.24*	1.43	0.00	1.43
46.40	0.15	0.62	0.24*	1.41	0.00	1.41
46.45	0.15	0.62	0.24*	1.39	0.00	1.39
46.50	0.15	0.62	0.24*	1.37	0.00	1.37
46.55	0.15	0.62	0.24*	1.35	0.00	1.35
46.60	0.15	0.62	0.24*	1.33	0.00	1.33
46.65	0.15	0.62	0.24*	1.31	0.00	1.31
46.70	0.15	0.62	0.24*	1.30	0.00	1.30
46.75	0.15	0.62	0.24*	1.28	0.00	1.28
46.80	0.15	0.62	0.24*	1.26	0.00	1.26
46.85	0.15	0.62	0.24*	1.24	0.00	1.24
46.90	0.15	0.62	0.24*	1.22	0.00	1.22
46.95	0.15	0.62	0.24*	1.20	0.00	1.20
47.00	0.15	0.62	0.24*	1.18	0.00	1.18
47.05	0.15	0.62	0.24*	1.16	0.00	1.16
47.10	0.15	0.62	0.24*	1.14	0.00	1.14
47.15	0.15	0.62	0.24*	1.12	0.00	1.12
47.20	0.15	0.62	0.24*	1.10	0.00	1.10
47.25	0.15	0.62	0.24*	1.08	0.00	1.08
47.30	0.15	0.62	0.24*	1.06	0.00	1.06
47.35	0.15	0.61	0.24*	1.04	0.00	1.04

47.40	0.15	0.61	0.24*	1.02	0.00	1.02
47.45	0.15	0.61	0.24*	1.00	0.00	1.00
47.50	0.15	0.61	0.24*	0.98	0.00	0.98
47.55	0.15	0.61	0.24*	0.96	0.00	0.96
47.60	0.15	0.61	0.24*	0.94	0.00	0.94
47.65	0.15	0.61	0.24*	0.92	0.00	0.92
47.70	0.15	0.61	0.24*	0.90	0.00	0.90
47.75	0.15	0.61	0.24*	0.89	0.00	0.89
47.80	0.15	0.61	0.24*	0.87	0.00	0.87
47.85	0.15	0.61	0.24*	0.85	0.00	0.85
47.90	0.15	0.61	0.24*	0.83	0.00	0.83
47.95	0.15	0.61	0.24*	0.81	0.00	0.81
48.00	0.15	0.61	0.24*	0.79	0.00	0.79
48.05	0.15	0.61	0.24*	0.77	0.00	0.77
48.10	0.15	0.61	0.24*	0.75	0.00	0.75
48.15	0.15	0.61	0.24*	0.73	0.00	0.73
48.20	0.15	0.61	0.24*	0.71	0.00	0.71
48.25	0.15	0.61	0.24*	0.69	0.00	0.69
48.30	0.15	0.61	0.24*	0.67	0.00	0.67
48.35	0.15	0.61	0.24*	0.65	0.00	0.65
48.40	0.15	0.61	0.24*	0.63	0.00	0.63
48.45	0.15	0.61	0.24*	0.61	0.00	0.61
48.50	0.15	0.61	0.24*	0.59	0.00	0.59
48.55	0.15	0.61	0.24*	0.57	0.00	0.57
48.60	0.15	0.61	0.24*	0.55	0.00	0.55
48.65	0.15	0.61	0.24*	0.53	0.00	0.53
48.70	0.14	0.61	0.24*	0.51	0.00	0.51
48.75	0.14	0.61	0.24*	0.49	0.00	0.49
48.80	0.14	0.61	0.24*	0.47	0.00	0.47
48.85	0.14	0.61	0.24*	0.45	0.00	0.45
48.90	0.14	0.61	0.24*	0.43	0.00	0.43
48.95	0.14	0.61	0.24*	0.41	0.00	0.41
49.00	0.14	0.61	0.24*	0.39	0.00	0.39
49.05	0.14	0.61	0.24*	0.37	0.00	0.37
49.10	0.14	0.61	0.24*	0.36	0.00	0.36
49.15	0.14	0.61	0.24*	0.34	0.00	0.34
49.20	0.14	0.61	0.24*	0.32	0.00	0.32
49.25	0.14	0.61	0.24*	0.30	0.00	0.30
49.30	0.14	0.61	0.24*	0.28	0.00	0.28
49.35	0.14	0.61	0.24*	0.26	0.00	0.26
49.40	0.14	0.60	0.24*	0.24	0.00	0.24
49.45	0.14	0.60	0.24*	0.22	0.00	0.22
49.50	0.14	0.60	0.24*	0.20	0.00	0.20
49.55	0.14	0.60	0.24*	0.18	0.00	0.18
49.60	0.14	0.60	0.24*	0.16	0.00	0.16
49.65	0.14	0.60	0.24*	0.14	0.00	0.14
49.70	0.14	0.60	0.24*	0.12	0.00	0.12
49.75	0.14	0.60	0.24*	0.10	0.00	0.10
49.80	0.14	0.60	0.24*	0.08	0.00	0.08
49.85	0.14	0.60	0.24*	0.06	0.00	0.06

49.90	0.14	0.60	0.24*	0.04	0.00	0.04
49.95	0.14	0.60	0.24*	0.02	0.00	0.02
50.00	0.14	0.60	0.24*	0.00	0.00	0.00

* F.S.<1, Liquefaction Potential Zone
(F.S. is limited to 5, CRR is limited to 2, CSR is limited to 2)

Units: Unit: qc, fs, Stress or Pressure = atm (1.0581tsf); Unit Weight = pcf; Depth = ft; Settlement = in.

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1 atm (atmosphere) = 1 tsf (ton/ft2)
CRRm Cyclic resistance ratio from soils
CSRsf Cyclic stress ratio induced by a given earthquake (with user request factor of safety)
F.S. Factor of Safety against liquefaction, F.S.=CRRm/CSRsf
S_sat Settlement from saturated sands
S_dry Settlement from Unsaturated Sands
S_all Total Settlement from Saturated and Unsaturated Sands
NoLiq No-Liquefy Soils

Appendix B

Key to Exploratory Boring Logs
and
Boring Logs

KEY TO EXPLORATORY BORING LOGS

SOIL CLASSIFICATIONS

PRIMARY DIVISIONS			GROUP1 SYMBOL	SECONDARY DIVISIONS
COARSE GRAINED SOILS More than half of material is larger than No. 200 sieve size	GRAVELS More than half coarse fraction is larger than No.4 sieve	Clean Gravels (less than5% fines*)	GW	Well graded gravels, gravel-sand mixtures, little or no fines
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines
		Gravel with fines*	GM	Silty gravels, gravel-sand-silt mixtures, non-plastic fines
			GC	Clayey gravels, gravel-sand-clay mixtures, plastic fines
	SANDS More than half coarse fraction is smaller than No.4 sieve	Clean Sands (less than 5%fines*)	SW	Well graded sands, gravelly sands, little or no fines
			SP	Poorly graded sands or gravelly sands, little or no fines
		Sands with fines*	SM	Silty sands, silt-sand mixtures, non-plastic fines
			SC	Clayey sand, sand-clay mixtures, plastic fines
FINE GRAINED SOILS More than half of material is smaller than No. 200 sieve size	SILTS AND CLAYS Liquid limit is less than 35		ML	Inorganic silts, clayey silts, rock flour, silty very fine sands
			CL	Inorganic clays of low plasticity, gravelly clay of low plasticity
			OL	Organic silts and organic silty clays of low plasticity
	SILTS AND CLAYS Liquid limit is between35 and 50		MI	Inorganic silts, clayey silts and silty fine sand with intermediate plasticity
			CI	Inorganic clays, gravely clays, sandy clays and silty clays of intermediate plasticity
			OI	Organic clays and silty clays of intermediate plasticity
	SILTS AND CLAYS Liquid limit is greater than 50		MH	Inorganic silts, clayey silts, elastic silts, micaceous or diatomaceous silty or fine sandy soil
			CH	Inorganic clays of high plasticity
			OH	Organic clays and silts of high plasticity
HIGHLY ORGANIC SOILS			Pt	Peat, meadow mat, highly organic soils

GRAIN SIZES

U.S. STANDARD SERIES SIEVE					CLEAR SQUARE SIEVE OPENINGS			
200	40		10	4	¾"	3"	12"	
Silts and Clays	Fine	Medium	Coarse	Fine	Coarse	Cobbles	Boulders	
	SAND			GRAVEL				

RELATIVE DENSITY

SANDS, GRAVELS AND NON-PLASTIC SILTS	BLOWS/FOOT*
VERY LOOSE	0 – 4
LOOSE	4 – 10
MEDIUM DENSE	10 – 30
DENSE	30 – 50
VERY DENSE	OVER 50

CONSISTENCY

CLAYS AND PLASTIC SILTS	UNCONFINED SHEAR STRENGTH (PSF)	BLOWS/FOOT*
VERY SOFT	0 – 250	0 – 2
SOFT	250-500	2 – 4
FIRM	500-1000	4 – 8
STIFF	1000-2000	8 – 16
VERY STIFF	2 000– 4000	16 – 32
HARD	>4000	OVER 32

SYMBOLS

▽	Initial Ground Water Level
▽	Final Ground Water Level
S	Standard Penetration Sampler
M	Modified California Sampler
D	Dames & Moore Sampler

NOTES

*BLOWS per FOOT – Resistance to advance the soil sampler in number of blows of a 140-pound hammer falling 30 inches to drive a split spoon sampler.

Stratification lines on the logs represent the approximate boundary between soil types, and the transition may be gradual.

Modified California Sampler – 2 ½ O.D. (1 7/8 Inch I.D.) sampler

Standard Penetration Sampler – 2 inch O.D. (1 3/8 Inch I.D.) split spoon sampler (ASTM D1586).

Dames & Moore Sampler – 3 inch O.D. (2.5 inch I.D.) sampler

FRIAR ASSOCIATES, INC.

BORING LOG

No. B-1

PROJECT Proposedf Industrial Building | DATE 06/04/18 | LOGGED BY cj

DRILL RIG SoilTest Ranger on F350 Flatbed | HOLE DIA. 4" | SAMPLER D - D&M; M - Mod Cal; S - S.P.T

GROUND WATER DEPTH INITIAL 7-5" | FINAL 7'-0" | HOLE ELEVATION 15ft

DESCRIPTION	SOIL TYPE	DEPTH	SAMPLE	BLOWS PER FOOT	POCKET PEN (tsf)	TORVANE (tsf)	LIQUID LIMIT (%)	WATER CONTENT (%)	PLASTIC LIMIT (%)	DRY DENSITY (pcf)	FAILURE STRAIN (%)	UNCONFINED COMPRESSIVE STRENGTH (psf)
Black and greenish-graysilty CLAY with gravel and sand (slightly moist) (firm) Fill	CH	1	D									
		2	D									
		3	D	23				17.2		106		
Black silty CLAY (very moist) (firm)	CH	4										
		5										
		6	D									
		7	D	24				28.8		92		3376
		8										
		9										
		10										
		11	D									
		12	D	25				25.0		98		
grades lighter in color		13										
		14										
		15										
Greenish-brown silty, sandy CLAY (very moist)	CL	16	D									
		17	D	18				22.3		100		
		18										
		19	D									
		20	D	27				20.6		102		

BORING LOG

No. B-1 Cont'd

PROJECT Proposed Industrial Building | DATE 06/04/18 | LOGGED BY cj

DRILL RIG SoilTest Ranger on F350 Flatbed | HOLE DIA. 4" | SAMPLER D - D&M; M - Mod Cal; S - S.P.T

GROUND WATER DEPTH INITIAL 7-5" | FINAL 7'-0" | HOLE ELEVATION 15ft

DESCRIPTION	SOIL TYPE	DEPTH	SAMPLE	BLOWS PER FOOT	POCKET PEN (tsf)	TORVANE (tsf)	LIQUID LIMIT (%)	WATER CONTENT (%)	PLASTIC LIMIT (%)	DRY DENSITY (pcf)	FAILURE STRAIN (%)	UNCONFINED COMPRESSIVE STRENGTH (psf)
Greenish-brown silty, sandy CLAY (very moist) (stiff)	CL	21	D									
			D									
			D	27				20.6		102		
		22										
		23										
		24										
		25										
			D									
		26	D									
			D	22				25.0		96		
		27										
less clayey		28										
		29										
		30										
Greenish-gray silty SAND (slightly moist) (medium dense)	SM		D									
		31	D									
			D	24								
		32										
		33										
		34										
some gravel		35										
		36										
		37										
		38										
		39										
		40										

BORING LOG

No. B-1Cont'd

PROJECT Proposed Industrial Building | DATE 06/04/18 | LOGGED BY cj

DRILL RIG SoilTest Ranger on F350 Flatbed | HOLE DIA. 4" | SAMPLER D - D&M; M - Mod Cal; S - S.P.T

GROUND WATER DEPTH INITIAL 7-5" | FINAL 7'-0" | HOLE ELEVATION 15ft

DESCRIPTION	SOIL TYPE	DEPTH	SAMPLE	BLOWS PER FOOT	POCKET PEN (tsf)	TORVANE (tsf)	LIQUID LIMIT (%)	WATER CONTENT (%)	PLASTIC LIMIT (%)	DRY DENSITY (pcf)	FAILURE STRAIN (%)	UNCONFINED COMPRESSIVE STRENGTH (psf)
Greenish-brown silty SAND with gravel (slightly moist) (medium dense)	SP	41	D									
			D									
			D	37				14.1		98		
		42										
		43										
		44										
		45										
			D									
with more gravel		46	D									
			D	20				14.3		106		
		47										
some cave in		48										
		49										
		50										
Bottom Of Hole At 50 Feet		51										
		52										
		53										
		54										
		55										
		56										
		57										
		58										
		59										
		60										

BORING LOG

No. B-2

PROJECT Proposed Industrial Building | DATE 06/04/18 | LOGGED BY cj

DRILL RIG SoilTest Ranger on F350 Flatbed | HOLE DIA. 4" | SAMPLER D - D&M; M - Mod Cal; S - S.P.T

GROUND WATER DEPTH INITIAL 7-5" | FINAL 7'-0" | HOLE ELEVATION 15ft

DESCRIPTION	SOIL TYPE	DEPTH	SAMPLE	BLOWS PER FOOT	POCKET PEN (tsf)	TORVANE (tsf)	LIQUID LIMIT (%)	WATER CONTENT (%)	PLASTIC LIMIT (%)	DRY DENSITY (pcf)	FAILURE STRAIN (%)	UNCONFINED COMPRESSIVE STRENGTH (psf)
Black silty CLAY with rock and brick pieces (very moist) (firm) Fill	CH	1										
some debris and asphalt pieces			D									
		2	D									
more brick pieces			D	27				31.8		85		
		3										
Dark gray to black silty CLAY (moist) (firm)	CH	4										
soft		5								▽ ▼		
no recovery			D									
		6	D									
			D	16								
		7										
		8										
		9										
		10										
Dark gray silty CLAY (very moist) (firm)	CL		D									
		11	D									
			D	27				27.8		93		4646
		12										
		13										
		14										
		15										
			D									
		16	D									
			D	17								
		17										
		18										
		19	D									
			D									
Bottom Of Hole At 20 Feet		20	D	18								

Project # 1822-2 **FRIAR ASSOCIATES, INCORPORATED** Page 1 of 1

BORING LOG

No. B-3

PROJECT Proposed Industrial Building | DATE 06/04/18 | LOGGED BY jhf

DRILL RIG SoilTest Ranger on F350 Flatbed | HOLE DIA. 4" | SAMPLER D - D&M; M - Mod Cal; S - S.P.T

GROUND WATER DEPTH INITIAL 7-5" | FINAL 7'-0" | HOLE ELEVATION 15ft

DESCRIPTION	SOIL TYPE	DEPTH	SAMPLE	BLOWS PER FOOT	POCKET PEN (tsf)	TORVANE (tsf)	LIQUID LIMIT (%)	WATER CONTENT (%)	PLASTIC LIMIT (%)	DRY DENSITY (pcf)	FAILURE STRAIN (%)	UNCONFINED COMPRESSIVE STRENGTH (psf)
Dark brown silty CLAY with sand and gravel (very moist) (firm) Fill	CH	1	D									
with debris and rock pieces		2	D									
		3	D	18				18.9		97		
		4										
Black silty CLAY (very moist) (firm)	CL	5								▽ ▼		
No recovery; disturbed sample			D									
stiff		6	D									
			D	35				22.3				
		7										
		8										
		9										
		10										
			S									
		11	S									
grades lighter in color			S	16				25,5				
		12										
		13										
		14										
		15										
			S									
		16	S									
			S	13								
		17										
		18										
		19	S									
			S									
Bottom Of Hole At 20 Feet		20	S	15								

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Appendix C

Laboratory Test Results

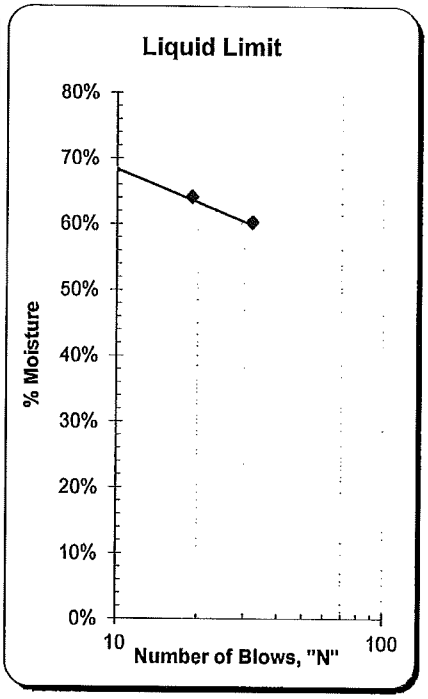
Date Received: 06/24/18
Sample #: 1
Sample ID: 1(R-2)
Source:

Project: 1822-2
Location: Cen
Boring #: 1
Depth: 5.00

ASTM D-2487, Unified Soils Classification System
Black high plastic CLAY

Liquid Limit Determination

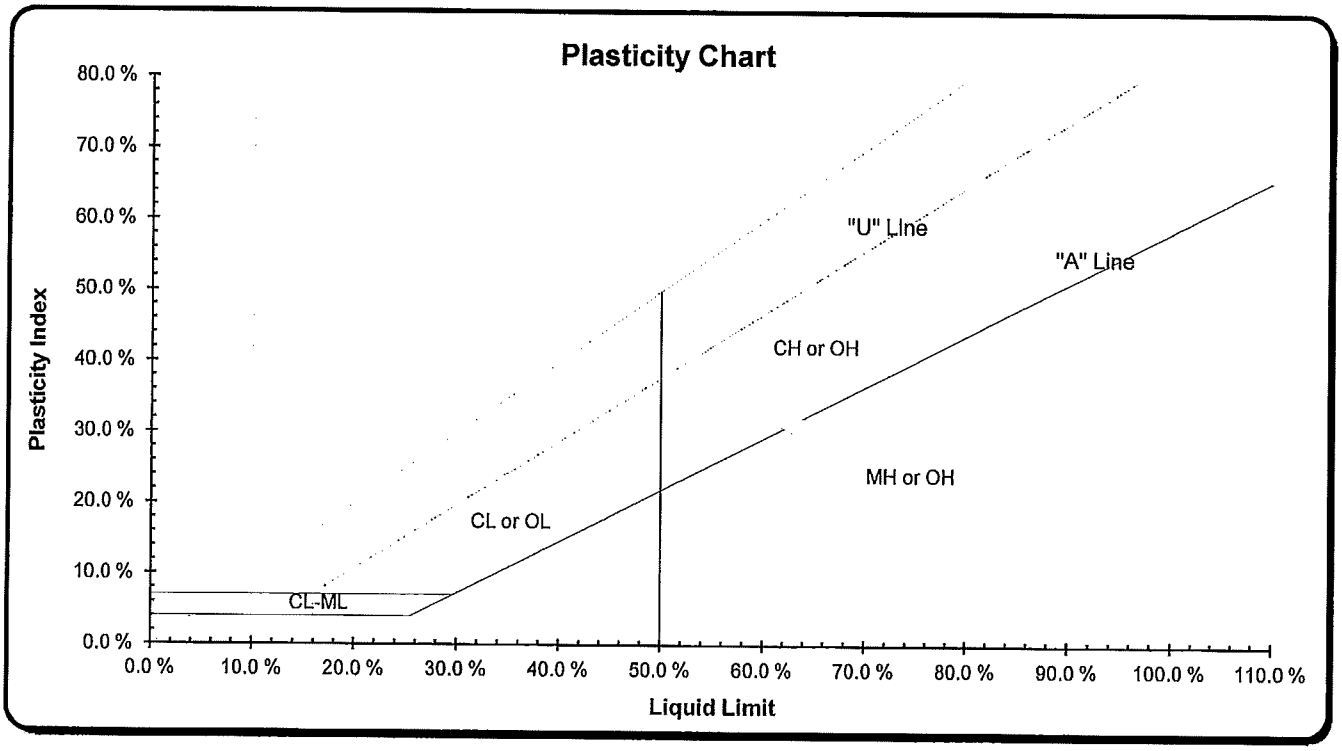
	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	47.24	48.93	48.18			
Weight of Dry Soils + Pan:	34.23	35.95	35.91			
Weight of Pan:	15.60	15.76	15.61			
Weight of Dry Soils:	18.63	20.19	20.30			
Weight of Moisture:	13.01	12.98	12.27			
% Moisture:	69.8 %	64.3 %	60.4 %			
N:	9	19	32			

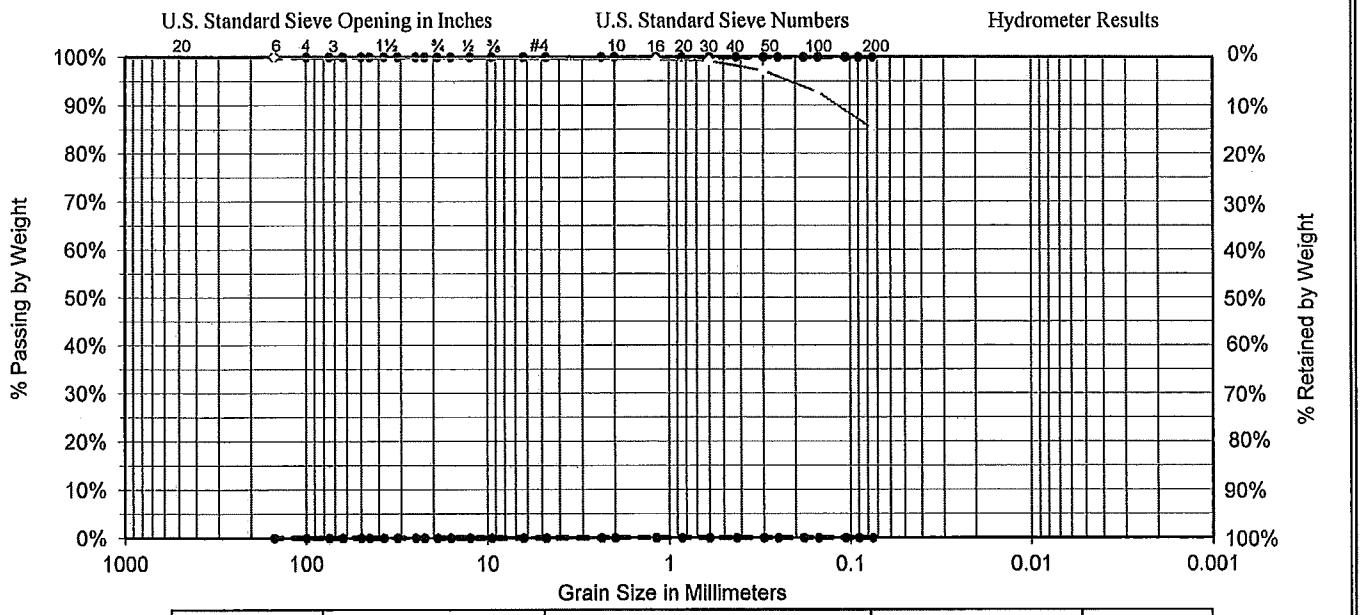


Liquid Limit @ 25 Blows: 62.8 %
Plastic Limit: 31.2 %
Plasticity Index, I_P: 31.7 %

Plastic Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	31.15					
Weight of Dry Soils + Pan:	27.48					
Weight of Pan:	15.70					
Weight of Dry Soils:	11.78					
Weight of Moisture:	3.67					
% Moisture:	31.2 %					





Cobbles	Gravels		Sands			Silts	Clays
	Coarse	Fine	Coarse	Medium	Fine		

Date ; 06/25/18
Sample #: R-6
Sample ID: 1(R-6)
Source: On-Site
Project: Matrix Project
Location: 1091 Doolittle
Boring #: B-1
Depth: 25'

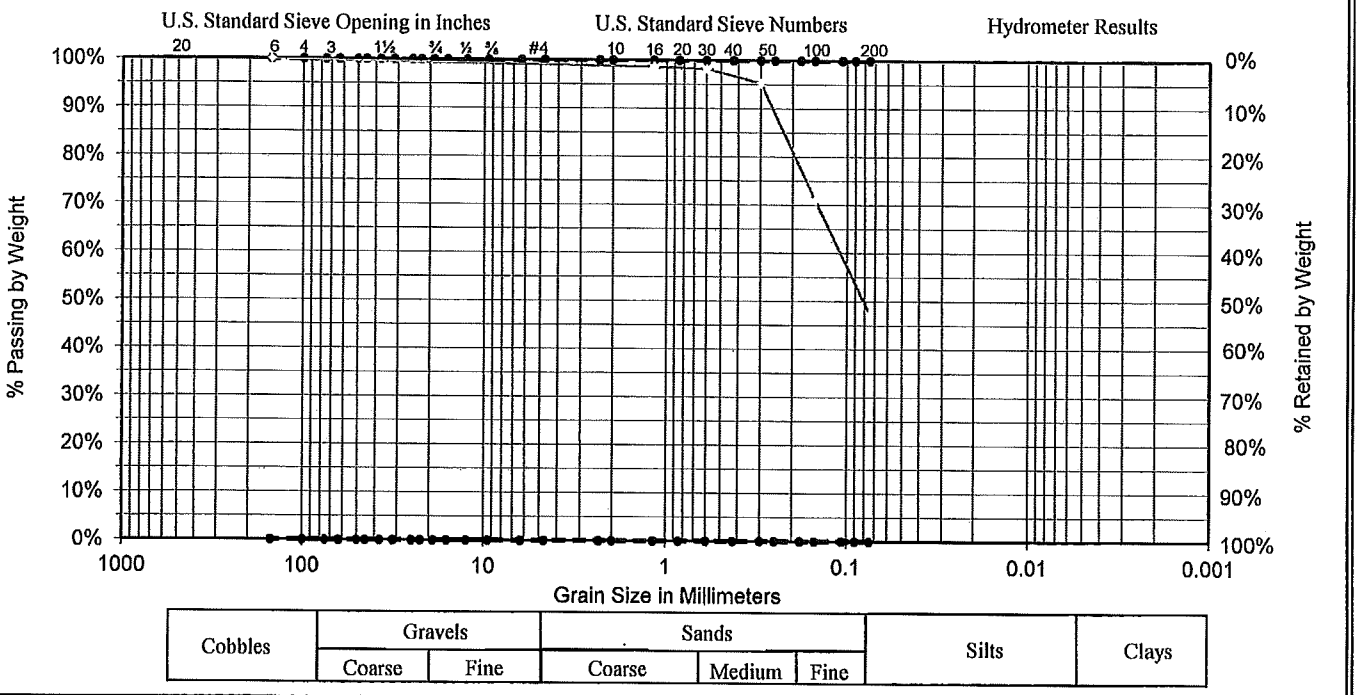
D_{10} = 0.01
D_{30} = 0.03
D_{60} = 0.05
C_C = 1.50
C_U = 6.00
Liquid Limit= 0.0%
Plastic Limit= 0.0%
Plasticity Index= 0.0%

USCS Classification
ML, Silt
Specifications
No Specs
Sample Meets Specs
n/a
Fineness Modulus
0.11

% Gravel	% Sand
0.0%	14.9%

% Silt & Clay
85.1%

Coarse Section		Actual Cumulative	Interpolated Cumulative			Fines Section		Actual Cumulative	Interpolated Cumulative		
Sieve Size		Percent	Percent	Specs	Specs	Sieve Size		Percent	Percent	Specs	Specs
US	Metric	Passing	Passing	Max	Min	US	Metric	Passing	Passing	Max	Min
6.00"	150.00		100.0%			#4	4.750		100.0%		
4.00"	100.00		100.0%			#8	2.360		100.0%		
3.00"	75.00		100.0%			#10	2.000		100.0%		
2.50"	63.00		100.0%			#16	1.180	99.5%	99.5%		
2.00"	50.00		100.0%			#20	0.850		99.4%		
1.75"	45.00		100.0%			#30	0.600	99.2%	99.2%		
1.50"	37.50		100.0%			#40	0.425		98.0%		
1.25"	31.50		100.0%			#50	0.300	97.2%	97.2%		
1.00"	25.00		100.0%			#60	0.250		95.7%		
7/8"	22.40		100.0%			#80	0.180		93.7%		
3/4"	19.00		100.0%			#100	0.150	92.8%	92.8%		
5/8"	16.00		100.0%			#140	0.106		88.3%		
1/2"	12.50		100.0%			#170	0.090		86.6%		
3/8"	9.50		100.0%			#200	0.075	85.1%	85.1%		
1/4"	6.30		100.0%			#270	0.053				
#4	4.75		100.0%								

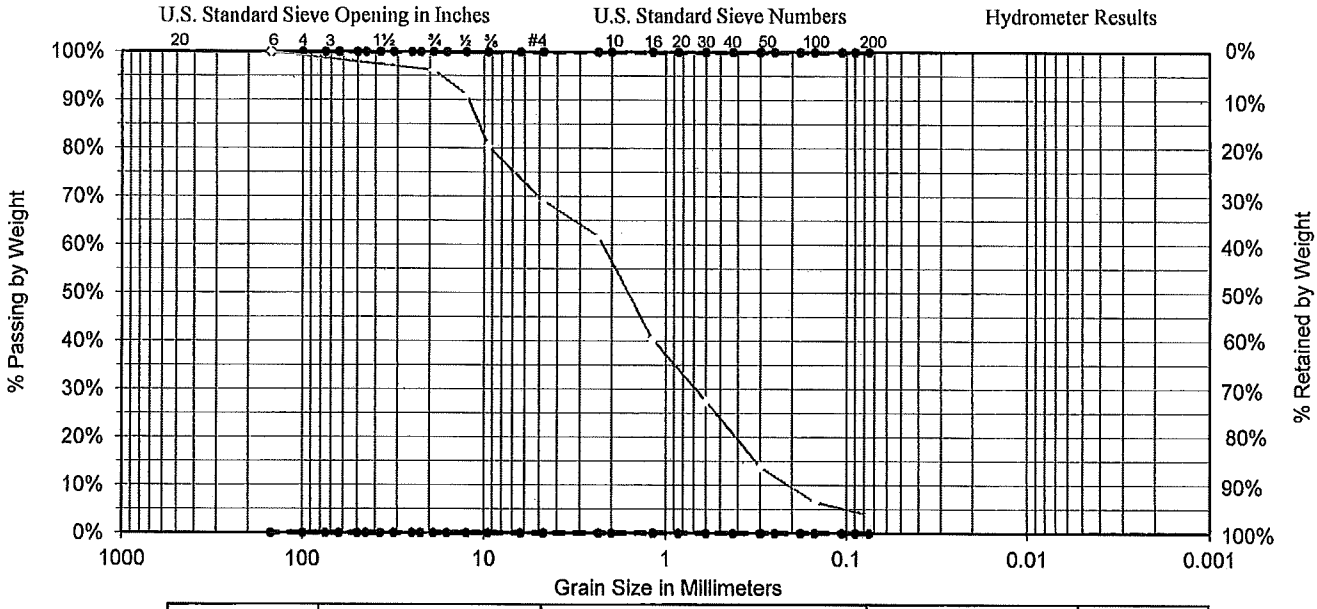


Cobbles	Gravels		Sands			Silts	Clays
	Coarse	Fine	Coarse	Medium	Fine		

Date : 06/25/18	D_{10} = 0.02	**USCS Classification**	% Gravel	% Sand
Sample #: R-7	D_{30} = 0.05	SM, Silty Sand	0.0%	52.6%
Sample ID: 1(R-7)	D_{60} = 0.12	**Specifications**		
Source: On-Site	C_C = 1.24	No Specs		
Project: Matrix Project	C_U = 7.27	Sample Meets Specs	% Silt & Clay	
Location: 1091 Doolittle	Liquid Limit= 0.0%	n/a	47.4%	
Boring #: B-1	Plastic Limit= 0.0%	Fineness Modulus		
Depth: 30'	Plasticity Index= 0.0%	0.37		

Coarse Section		Actual Cumulative	Interpolated Cumulative		
Sieve Size		Percent	Percent	Specs	Specs
US	Metric	Passing	Passing	Max	Min
6.00"	150.00		100.0%		
4.00"	100.00		100.0%		
3.00"	75.00		100.0%		
2.50"	63.00		100.0%		
2.00"	50.00		100.0%		
1.75"	45.00		100.0%		
1.50"	37.50		100.0%		
1.25"	31.50		100.0%		
1.00"	25.00		100.0%		
7/8"	22.40		100.0%		
3/4"	19.00		100.0%		
5/8"	16.00		100.0%		
1/2"	12.50		100.0%		
3/8"	9.50		100.0%		
1/4"	6.30		100.0%		
#4	4.75		100.0%		

Fines Section		Actual Cumulative	Interpolated Cumulative		
Sieve Size		Percent	Percent	Specs	Specs
US	Metric	Passing	Passing	Max	Min
#4	4.750		100.0%		
#8	2.360		100.0%		
#10	2.000		100.0%		
#16	1.180	98.6%	98.6%		
#20	0.850		98.4%		
#30	0.600	98.3%	98.3%		
#40	0.425		96.6%		
#50	0.300	95.3%	95.3%		
#60	0.250		87.2%		
#80	0.180		75.9%		
#100	0.150	71.0%	71.0%		
#140	0.106		57.2%		
#170	0.090		52.1%		
#200	0.075	47.4%	47.4%		
#270	0.053				

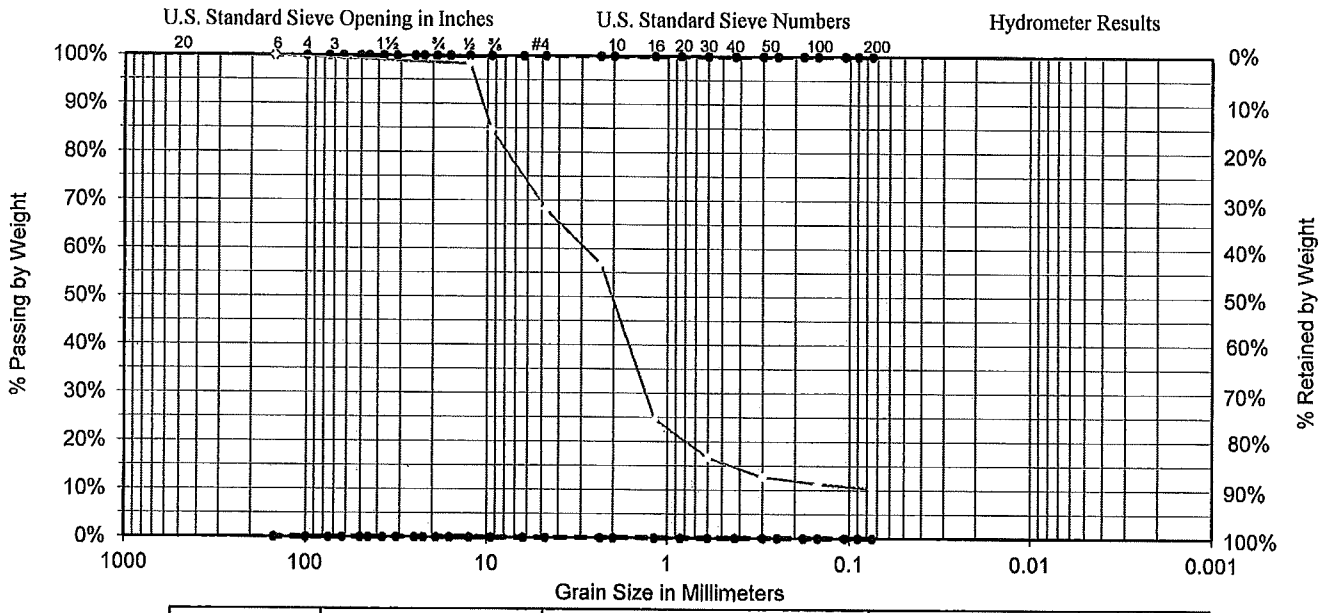


Cobbles	Gravels		Sands			Silts	Clays
	Coarse	Fine	Coarse	Medium	Fine		

Date : 06/25/18	D_{10} = 0.22	**USCS Classification**	% Gravel	% Sand
Sample #: R-8	D_{30} = 0.71	SW, Well-graded Sand wi	30.9%	65.2%
Sample ID: 1(R-8)	D_{60} = 2.27	**Specifications**		
Source: On-Site	C_C = 1.01	No Specs		
Project: Matrix Project	C_U = 10.22	Sample Meets Specs	% Silt & Clay	
Location: 1091 Doolittle	Liquid Limit= 0.0%	n/a	3.9%	
Boring #: B-1	Plastic Limit= 0.0%	Fineness Modulus		
Depth: 40'	Plasticity Index= 0.0%	4.05		

Coarse Section		Actual Cumulative	Interpolated Cumulative		
Sieve Size US	Sieve Size Metric	Percent Passing	Percent Passing	Specs Max	Specs Min
6.00"	150.00		100.0%		
4.00"	100.00		100.0%		
3.00"	75.00		100.0%		
2.50"	63.00		100.0%		
2.00"	50.00		100.0%		
1.75"	45.00		100.0%		
1.50"	37.50		100.0%		
1.25"	31.50		100.0%		
1.00"	25.00		100.0%		
7/8"	22.40		100.0%		
3/4"	19.00	96.2%	96.2%		
5/8"	16.00		93.8%		
1/2"	12.50	91.0%	91.0%		
3/8"	9.50	80.5%	80.5%		
1/4"	6.30		72.8%		
#4	4.75	69.1%	69.1%		

Fines Section		Actual Cumulative	Interpolated Cumulative		
Sieve Size US	Sieve Size Metric	Percent Passing	Percent Passing	Specs Max	Specs Min
#4	4.750	69.1%	69.1%		
#8	2.360	61.7%	61.7%		
#10	2.000		55.1%		
#16	1.180	40.2%	40.2%		
#20	0.850		33.0%		
#30	0.600	27.5%	27.5%		
#40	0.425		19.5%		
#50	0.300	13.8%	13.8%		
#60	0.250		11.4%		
#80	0.180		8.0%		
#100	0.150	6.5%	6.5%		
#140	0.106		5.0%		
#170	0.090		4.4%		
#200	0.075	3.9%	3.9%		
#270	0.053				



Cobbles	Gravels		Sands			Silts	Clays
	Coarse	Fine	Coarse	Medium	Fine		

Date : 06/25/18	D_{10} = 0.07	**USCS Classification**	% Gravel	% Sand
Sample #: R-9	D_{30} = 1.37	SP-SM, Poorly graded Sai	31.7%	57.8%
Sample ID: 1(R-9)	D_{60} = 3.01	**Specifications**		
Source: On-Site	C_C = 8.71	No Specs		
Project: Matrix Project	C_U = 41.87	Sample Meets Specs	% Silt & Clay	
Location: 1091 Doolittle	Liquid Limit= 0.0%	n/a	10.4%	
Boring #: B-1	Plastic Limit= 0.0%	Fineness Modulus		
Depth: 45'	Plasticity Index= 0.0%	4.25		

Coarse Section		Actual Cumulative	Interpolated Cumulative		
Sieve Size		Percent	Percent	Specs	Specs
US	Metric	Passing	Passing	Max	Min
6.00"	150.00		100.0%		
4.00"	100.00		100.0%		
3.00"	75.00		100.0%		
2.50"	63.00		100.0%		
2.00"	50.00		100.0%		
1.75"	45.00		100.0%		
1.50"	37.50		100.0%		
1.25"	31.50		100.0%		
1.00"	25.00		100.0%		
7/8"	22.40		100.0%		
3/4"	19.00		100.0%		
5/8"	16.00		100.0%		
1/2"	12.50	98.3%	98.3%		
3/8"	9.50	84.6%	84.6%		
1/4"	6.30		73.6%		
#4	4.75	68.3%	68.3%		

Fines Section		Actual Cumulative	Interpolated Cumulative		
Sieve Size		Percent	Percent	Specs	Specs
US	Metric	Passing	Passing	Max	Min
#4	4.750	68.3%	68.3%		
#8	2.360	56.9%	56.9%		
#10	2.000		47.1%		
#16	1.180	24.7%	24.7%		
#20	0.850		20.2%		
#30	0.600	16.7%	16.7%		
#40	0.425		14.4%		
#50	0.300	12.7%	12.7%		
#60	0.250		12.3%		
#80	0.180		11.6%		
#100	0.150	11.3%	11.3%		
#140	0.106		10.8%		
#170	0.090		10.6%		
#200	0.075	10.4%	10.4%		
#270	0.053				

GEOTECHNICAL INVESTIGATION
AND LIQUEFACTION EVALUATION
PROPOSED INDUSTRIAL BUILDING
DOOLITTLE ROAD
SAN LEANDRO, CALIFORNIA

INTRODUCTION

This report presents the results of the geotechnical investigation and liquefaction evaluation we conducted at the site for the planned industrial buildings for the Alcoa Iron and Metal Company. The proposed building sites are located in area at the northwest corner of the intersection Davis Street with Doolittle Drive in San Leandro, California. The general location of the site is shown on the attached Vicinity Map, Figure 1.

BACKGROUND

Alco Iron and Metal plans to add on to their existing building located at the northwest corner of the intersection of Davis Street and Doolittle Drive. Further to the west of the existing building, Alco Iron and Metal plan to support an existing mobile office on permanent foundations. In addition, Alco Metal and Iron plans to pave another area between the planned addition site and the mobile office and use the area for parking.

PROPOSED CONSTRUCTION

Details of the proposed development were not available at the time of preparing this report. However, we have assumed that the proposed industrial building addition will be of either wood or steel frame construction with a concrete slab-on-grade floor. We understand that the mobile office will be supported on a permanent foundation system and no other improvements will be done to the structure. The new parking area will be asphalt concrete. The existing conditions at the proposed construction area are shown on the attached Site Plan, Figure 2.

INFORMATION PROVIDED

We were provided with an electronic format (pdf) copy of a site plan showing the proposed addition site, the mobile office structure and the area proposed for the new at-grade parking. The site plan (no date) was prepared by CRJ Architects, Inc. We were provided with a site topographic map showing the existing site conditions. The site topographic ma dated November 2017, was prepared by Kier & Wright Civil Engineers. A copy of the site plan by CRJ Architects was used to prepare our Site Plan, Figure 2 which also shows the approximate location of the exploratory holes we excavated as part of this investigation.

SCOPE OF WORK

Our scope of work was to evaluate the site conditions (surface and subsurface) from a geotechnical engineering viewpoint and to develop information for the design and construction of the proposed building foundations and other geotechnically related portions of the planned construction. Specifically, we performed the following work:

1. Made a site reconnaissance visit and site meeting with a representative of Alco Iron and Metal to evaluate the existing conditions at the site and plan the field exploration work.

2. Reviewed geologic and geotechnical information in our files pertinent to the site and the surrounding area.

3. Reviewed in-house files for projects we have completed in the vicinity of the site. We specifically reviewed our files for the work we did for the new Alco Iron and Metal building on Davis Street.

4. Explored, sampled and classified foundation soils by means of three small diameter exploratory holes to a maximum depth of 50 feet below the existing ground surface. The holes were logged by an engineer on staff who supervised the field exploration work and obtained samples for laboratory testing.

5. Performed laboratory testing on selected soil samples to evaluate their pertinent index and mechanical properties.

6. Collated and analyzed the field and laboratory data obtained to evaluate the liquefaction potential of the site subsurface soils under seismic loading and to provide recommendations and mitigation measures, if found necessary.

7. Based on the findings of the six items above, developed geotechnical recommendations for site preparation, grading and compaction; provided geotechnical information for the design and construction of the proposed building foundations, concrete slabs-on-grade, utility trench backfilling and site drainage.

8. Provided a minimum pavement sections for the driveway and parking areas.

9. Prepared this report to summarize our findings, conclusions and recommendations.

FINDINGS

Surface Conditions

The three sites for the planned construction are part of a large parcel of land located on the northwest corner of the intersection of Davis Street with Doolittle Drive. The referenced parcel consists of some industrial structures and open spaces that are generally used for storing scrap metals. The ground surface at the three sites is essentially level. The site for the proposed addition to the existing building is paved with asphalt concrete. The other two areas are unpaved. The average ground elevation at the site is between seven and eight feet above Mean Sea Level.

Subsurface Conditions

The descriptions given below pertain only to the subsurface conditions found at the site at the time of our subsurface exploration on June 4, 2018. Subsurface conditions, particularly ground water levels and the consistency of the near-surface soils, will vary with time and the seasons.

Subsurface conditions at the site were explored by means of three small diameter exploration holes to a maximum depth of 50 feet below the existing ground surface. Within the depth of our exploration, the exploratory holes encountered fill, clay, silt, sand and gravel.

The fill encountered consist of crushed rock and brown silty clay with brick pieces, asphalt concrete and some crushed rock. The fill is estimated to be between 24 inches and 36 inches in thickness. The near-surface native soils consist of dark gray to black moderately to highly plastic silty clay that is moist and stiff. This highly plastic clay extends to a depth of about 10 feet below the existing ground surface. Below 10 feet, the clay grades lighter in color to brown and greenish-brown with some sand. A layer of sand about 15 feet in thickness was encountered below the clay. The sand is saturated and medium dense. The sand is underlain by sandy clay to the maximum depth of exploration.

Groundwater was encountered at a depth of five feet and seven feet below the ground surface at the exploratory holes. The groundwater stabilized at those depths. Depth to groundwater is expected to fluctuate with time and the seasons.

Detailed descriptions of the materials encountered in the borings are given on the appended boring logs together with the results of some of the laboratory tests performed on selected samples obtained from the borings (see Appendix A). The results of the other laboratory tests are attached separately under Appendix C.

Seismic Considerations

This site is located within the seismically active San Francisco Bay region but outside of any of the Alquist-Priolo Earthquake Fault Zones.

Type A and Type B faults close to the site are listed in the following table.

TABLE 1 - TYPES A AND B FAULTS CLOSE TO THE SITE *

Fault	Type	Maximum Moment Magnitude	Slip Rate (mm/yr)	Distance (miles/km)
San Andreas (1906 Segment)	A	7.9	24	14.9/24
Hayward (Total Length)	A	7.1	9	3.1/5
Calaveras (North of Reservoir)	B	6.8	0.4	11.8/19

* California Division of Mines & Geology Open File Report 96-08

Seismic hazards can be divided into two general categories, hazards due to ground rupture and hazards due to ground shaking. Since no active faults are known to cross this property, the risk of earthquake-induced ground rupture occurring across the project site appears to be remote.

Should a major earthquake with an epicentral location close to the site occur, ground shaking at the site will undoubtedly be severe, as will be for other properties in the general vicinity of the site. Under the influence of severe ground shaking, the soils that underlie the area proposed may liquefy resulting in differential settlement across the project site and the adjacent area (see liquefaction analysis below).

The following general site seismic design information may be used in accordance with the 2016 California Building Code.

Site Coordinates: Latitude = 37.72; Longitude = -122.19
Site Class: D
Fa = 1.0, and Fv = 1.5

Spectral Response Accelerations SMs and SM1
SMs = FaSs and SM1 = FvS1
For Site Class D with Fa = 1.0, and Fv = 1.5

Period (sec)	Sa (g)	
0.2	1.748	(SMs, Site Class D)
1.0	1.041	(SM1, Site Class D)

SDs = 2/3 x SMs and SD1 = 2/3 x SM1
For Site Class D with Fa = 1.0, Fv = 1.5

Period (sec)	Sa (g)	
0.2	1.165	(SDs, Site Class D)
1.0	0.694	(SD1, Site Class D)

Liquefaction Analysis

Liquefaction is a commonly observed phenomenon during an earthquake. Liquefaction occurs when saturated sands lose their strength during an earthquake and become fluid-like and mobile. As a result, the ground may undergo large permanent displacements that can damage underground utilities and well-built surface structures. The displacements can either be vertical that may result in differential settlement or lateral spread. Lateral spreading is a major concern associated with liquefaction because it involves displacement of large blocks of ground down gentle slopes or towards stream channels.

We performed a liquefaction evaluation using a 7.5 Magnitude earthquake resulting in a peak ground acceleration of 0.61g (in accordance with Open File Report 2000-010) at the site. A groundwater level of 10 feet below the ground surface was used to perform the liquefaction evaluation.

Methodology

We performed the analysis using a software developed by CIVILTECH. The CIVILTECH software method is based on the most recent publications of the NCEER Workshop and DMG SP 117 Implementation. The software provides several methods for evaluating liquefaction potential including Seed's normalized SPT blow counts, BPT and CPT data. Our analysis was based on Seed's normalized SPT method. The calculation procedure used is divided into four parts:

1. Calculation of *cyclic stress ratio* (CSR, earthquake "load") induced in the soil by an earthquake.

2. Calculation of *cyclic resistance ratio* (CRR, soil "strength") based on in-situ test

data from SPT tests.

3. Evaluation of liquefaction potential by calculating a *factor of safety against liquefaction,* F.S., by dividing CRR by CSR.

4. Estimation of liquefied-induced settlement.

1. **Cyclic Stress Ration** is calculated using Seed's method, first introduced in 1971 (Seed and Idriss, 1971) and updated through summary papers by Seed and others and recently (1996) reviewed by participants in a workshop on liquefaction evaluation arranged by NCEER. The equation is as follows:

$$CSR = 0.65\sigma_0/\sigma_0' a_{max}\, r_d$$

where,

CSR is the cyclic stress ratio induced by a given earthquake

0.65 is a weighting factor introduced by Seed, to calculate the number of uniform stress cycles required to produce the same pore water pressure as an irregular earthquake ground motion.

σ_0 is the total vertical overburden stress

σ_0' is the effective vertical overburden stress

a_{max} is the Peak Horizontal Ground Acceleration, PGA, in g

r_d is a stress reduction coefficient determined by the formulas below (NCEER, 1997)

$r_d=1.0-0.00765z$ for $z< 9.15m$
$r_d=1.174-0.0267z$ for $9.15m<z<30m$
$r_d=0.5$ For $z>30m$

2. **Cyclic Resistance Ratio** (CRR) liquefaction curves are derived for an earthquake magnitude of 7.5 and is designated as $CRR_{7.5}$. To take different magnitudes into account, the factor of safety against liquefaction is multiplied by a magnitude scaling factor (MSF). In the graphical output of the analysis, the CSR is divided by the MSF to give an accurate view of the liquefied zone. The computation of $CRR_{7.5}$ from SPT is based on correction for the following:

blow count data (N_m)

depth correction factor (C_n)
hammer energy ratio (ER) correction factor (C_c)
borehole diameter correction factor (C_b)
rod length correction factor (C_r)
correction factor for samples with or without liners (C_s)

$CRR_{7.5}$ is determined by using a formula developed by Blake (1997). Blake used the corrected normalized SPT–value $(N_1)_{60}$.

3. **Ratio of CRR/CSR** The ratio of CRR/CSR is defined as Factor of Safety for liquefaction potential. If FS>1 or equal to 1, there is no potential for liquefaction. If F.S < 1, there is a potential of liquefaction.

4. **Settlement Calculation** is done in two parts, dry soil settlement and saturated soil settlement. The soil above the groundwater table is referred to as dry soil and soil below the groundwater table is referred to as saturated soil. **The total settlement is presented in the graphical report as a cumulative settlement curve versus depth**.

To evaluate the liquefaction induced lateral movement in the ground surface that could occur at the site as a result of a 7.5 Magnitude earthquake on the nearby Hayward Fault, an empirical method developed by Bartlett and Youd (1995) was used. The following equation was used: the equation is for determining lateral spreading of gently sloping ground as opposed to a free face.

$$\text{Log } D_H = -15.787+1.178M-0.927\log R-0.013R+0.429\log S+0.348\log T+4.527\log(100-F)-0.922D_{50}$$

where,

D_H is the ground displacement in meters
M is earthquake Magnitude
R is distance to the nearest fault rupture in kilometers
T is Cumulative thickness of the liquefiable soil layer in meters
F is percent finer than No. 200 sieve
D_{50} is grain size corresponding to 50% fine of liquefiable soil layer in millimeters
S is slope gradient of the ground surface

The data obtained from the laboratory tests was used to perform our analysis.

Our analysis shows that with a 7.5 Magnitude earthquake and a groundwater level of three feet below the ground surface, there is a potential for liquefaction at the site which may result in total

estimated cumulative ground settlement of a little over **1.27 inches** with **total differential settlement of between 0.637 of an inch and 0.841 of an inch across the site**. Lateral ground displacement is estimated to be almost unnoticeable as a result of a seismic event producing a ground liquefaction at the site given the site conditions (almost flat ground surface at the proposed building area as opposed to free face). Historical data does not indicate the effects of large scale lateral spreading at or near the vicinity of the property.

DISCUSSION

The principal geotechnical items that will impact the planned construction is the presence of undocumented fill near the surface of the proposed building site. The undocumented fill cannot be relied on to take the proposed building loads. This fill should be removed and replaced as structural fill.

Atterberg Limits tests performed on a sample of the near-surface clay shows the clay is moderately to highly plastic indicating a moderate to high potential for expansion. Expansive soil loses volume and shrinks when dry and expand when it gains water. The degree of expansion depends on the antecedent soil water content. The alternating shrink/swell cycles of expansive soils tend to have detrimental effects on foundation elements, particularly, slabs-on-grade. Foundation and concrete slabs-on-grade for the proposed building should be designed with this in mind.

To provide uniform support for the new building, we recommend that the top 24 inches of the new building pad be subexcavated and replaced with non-expansive fill cap. The new building may then be supported on conventional, shallow, footing-type foundations. Detail recommendations are provided in a section below.

RECOMMENDATIONS

The following recommendations, which are presented as guidelines to be used by project planners and designers, have been prepared assuming FRIAR ASSOCIATES, INCORPORATED will be commissioned to review the grading and foundation plans prior to construction, and to observe and test during site grading and foundation construction. This additional opportunity to inspect the project site will allow us to compare subsurface conditions exposed during construction with those that were observed during this investigation.

Site Preparation, Grading and Compaction

The site should be cleared of all unsuitable material and hauled off site. Areas of the site that are

landscaped and will be built on or paved should be stripped to remove organic-laden topsoil. Soils containing more than two percent by weight of organic matter should be considered organic. Any subsurface structure including old utility lines and buried pipes, electrical lines, landscape pipes, sanitary sewers and storm drains that may exist at the property and traverses the new building pad, should be excavated out, removed and hauled off-site or relocated away from the proposed building and pavement sites. The resulting voids and depressions from these operations should be backfilled with structural fill.

To provide uniform support for the proposed building, we recommend that the top 24 inches of soil exposed in the proposed building addition area and pavement areas after the removal of the unsuitable material be excavated out and replaced as structural fill. This subexcavation should extend at least five feet beyond the proposed building addition lines and three feet beyond new pavement edges. The soil exposed after the subexcavation should be scarified, conditioned with water (or allowed to dry) to a soil water content of at least three percent above the optimum water content and compacted to about 90 percent of the maximum dry density as determined by ASTM Test Method D1557-12.

Structural fill may then be placed up to design grades in the proposed building and pavement areas. Structural fill using approved import, should be placed in layers, each not exceeding eight inches thick (before compaction), conditioned with water (or allowed to dry, as necessary) to produce a soil water content of at least three percent above the optimum water content and then compacted to 90 percent relative compaction based on ASTM Test Method D1557-12.

Import soil required for use as structural fill, should be inorganic, should preferably have a low expansion potential and should be free from clods or rocks larger than four inches in largest dimension. Prior to delivery to the site, proposed import should be tested in our laboratory to verify its suitability for use as structural fill and, if found to be suitable, further tested to estimate the water content and density at which it should be placed.

New Building Foundations

The new buildings may be supported on conventional, shallow foundations bearing on properly compacted fill as recommended above under “Site Preparation, Grading And Compaction” or bearing on competent native, “undisturbed” soil.

Continuous, reinforced concrete foundations may be designed to impose pressures on foundation soils up to 2000 pounds per square foot from dead plus normal live loading. Continuous foundations should be at least 18 inches wide and should be embedded at least 24 inches below rough pad grade or adjacent finished grade, whichever is lower. <u>For the mobile office, foundation excavations should be at least 12 inches deep and 12 inches wide in smallest dimensions.</u>

Interior isolated foundations, such as may support column loads, may be designed to impose pressures on foundation soils up to 2000 pounds per square foot from dead plus normal live loading. Interior foundations should be embedded at least 24 inches below rough pad grade and should be at least 24 inches in smallest dimension.

The allowable soil pressures given above may be increased by one-third when evaluating the effects of short-term wind or seismic loadings

Total and differential post-construction settlement of foundations constructed as recommended above should be nominal.

For design purposes, horizontal passive resistance acting against foundations embedded in level native soil or compacted fill may be calculated assuming an equivalent fluid pressure of 250 pounds per cubic foot. The upper nine inches of embedment should be neglected when calculating horizontal passive resistance of the soil against the foundations unless the ground surface is paved. Alternatively, the ultimate horizontal friction force acting along the base of foundations may be calculated using a soil to concrete friction coefficient of 0.30. When both passive resistance and friction are combined, the lower value of the two should be reduced by 50 percent.

During foundation construction, care should be taken to minimize evaporation of water from foundation and floor subgrades. Scheduling the construction sequence to minimize the time interval between foundation excavation and concrete placement is important. Concrete should be placed only in foundation excavations that have been kept moist, are free from drying cracks and contain no loose or soft soil or debris. It is very critical that soil water content is maintained at least three percent over the optimum water content prior to placement of concrete.

Concrete Slabs-On-Grade

Concrete floor slabs should be constructed on compacted soil subgrades prepared as described in the section on Site Preparation, Grading and Compaction. Clayey subgrade for concrete slabs-on-grade areas should be water conditioned as recommended above to minimize post-construction detrimental effect of expansive soil. **It is important that concrete is placed only at subgrade soils that have been kept moist, particularly, for slab-on-grade areas.**

To minimize floor dampness, a section of capillary break material at least five inches thick and covered with a membrane vapor barrier should be placed between the floor slab and the compacted soil subgrade. The capillary break should be a free-draining material, such as 3/8" pea gravel or a permeable aggregate complying with CALTRANS Standard Specifications, Section 68, Class 1, Type A or Type B. The membrane vapor barrier should be a high quality. A protective cushion of sand or capillary break material at least two inches thick should be placed

between the membrane vapor barrier and the floor slab.

If floor dampness is not objectionable, concrete slabs may be constructed directly on a minimum six-inch thick compacted aggregate base over the water-conditioned and compacted soil subgrade. The aggregate base material should be compacted to at least 93 percent of the maximum dry density as determined by ASTM Test Method D1557-09.

Driveway Pavement

The near-surface soil at the site will have low support when used for pavement support; therefore, an R-value of 10 was assumed in pavement design calculations shown below. We recommend that R-value test of the pavement subgrade soil be performed when roadway subgrades are established to determine the actual pavement sections required based on projected Traffic Indices. Therefore, the design sections shown in the table below are preliminary.

TABLE 2 - RECOMMENDED MINIMUM ASPHALT CONCRETE PAVEMENT SECTIONS

Traffic Index (T.I.)	Asphalt Concrete (inches)	Class 2 Aggregate Base (inches)	Total Thickness (inches)
4.5	2.5	9.0	11.5
5.0	3.0	9.0	12.0
5.5	3.5	10.0	13.5
6.0	4.0	11.0	15.0

Pavement subgrades should be compacted as described above in the section under “Site Preparation Grading and Compaction”.

Curbs and gutters should be constructed directly on the soil subgrade rather than on a layer of aggregate base. This will minimize the amount of surface water that seeps below the curb and into the pavement subgrade. The seepage of water into subgrade soils beneath vehicle pavements, can result in subgrade softening and premature pavement distress.

Pavement construction should comply with the requirements of the CALTRANS Standard Specifications, latest editions, except that compaction requirements for pavement soil subgrades and aggregate base should be based on ASTM Test D1557-09, as described in the part of this report dealing with "Site Preparation, Grading and Compaction."

For a concrete driveway, the recommendations under Concrete Slab-On-Grade may be used for

light traffic. If heavier traffic is anticipated, the slab should be evaluated by the project structural engineer. The concrete slab should be at least four inches thick and should be reinforced with a minimum of No. 4 reinforcing bars. Reinforcing bars should have a minimum clear cover of 1.5 inches.

Utility Trenches

The attention of contractors, particularly the underground contractor, should be drawn to the requirements of California Code of Regulations, Title 8, Construction Code Section 1540 regarding Safety Orders for "Excavations, Trenches, Earthwork." Any temporary excavation deeper than five feet should be adequately shored. Temporary shoring may be designed using a lateral pressure of 45 pounds per cubic foot.

For purposes of this section of the report, bedding is defined as material placed in a trench up to one foot above any utility pipe and backfill is all material placed in the trench above the bedding.

Unless concrete bedding is required around utility pipes, free-draining sand should be used as bedding. Sand proposed for use in bedding should be tested in our laboratory to verify its suitability and to measure its compaction characteristics. Sand bedding should be compacted by mechanical means to achieve at least 90 percent compaction density based on ASTM Test Method D1557-12.

Approved, on-site, inorganic soil, or imported material may be used as utility trench backfill. Proper compaction of trench backfill will be necessary under and adjacent to structural fill, building foundations, concrete slabs and vehicle pavements. In these areas, backfill should be conditioned with water (or allowed to dry) to produce a soil-water content of about five percent above the optimum value and placed in horizontal layers not exceeding six inches in thickness (before compaction). Each layer should be compacted to 85-90 percent relative compaction based on ASTM Test D1557-12. The upper eight inches of pavement subgrades should be compacted to about 90 percent relative compaction based on ASTM Test D1557-12.

Where any trench crosses the perimeter foundation line of any building, the trench should be completely plugged and sealed with compacted clay soil for a horizontal distance of at least two feet on either side of the foundation.

Surface Drainage

Surface drainage gradients should be planned to prevent ponding and to promote drainage of surface water away from top of slopes, building foundations, slabs, edges of pavements and sidewalks, and toward suitable collection and discharge facilities.

Water seepage or the spread of extensive root systems into the soil subgrades of foundations, slabs, or pavements, could cause differential movements and consequent distress in these structural elements. This potential risk should be given due consideration in the design and construction of landscaping.

Subsurface Drainage

Due to high groundwater conditions at the property, it will be prudent to install subsurface drains around the perimeter of the new building foundations. We can provide recommendations for subsurface drainage system should project planners and designers decide to incorporate one as part of the proposed development.

Follow-up Geotechnical Services

Our recommendations are based on the assumption that FRIAR ASSOCIATES, INCORPORATED will be commissioned to perform the following services.

1. Review final grading and foundation plans prior to construction.

2. Observe, test and advise during grading, subexcavation for the proposed building pad and placement of structural fill.

3. Observe and advise during proposed building foundation excavations.

4. Observe, test and advise during utility trench backfilling.

LIMITATIONS

The recommendations contained in this report are based on certain plans, information and data that have been provided to us. Any change in those plans, information and data will render our recommendations invalid unless we are commissioned to review the change and to make any necessary modifications and/or additions to our recommendations.

Subsurface exploration of any site is necessarily confined to selected locations. Conditions may, and often do, vary between and around such locations. Should conditions different from those encountered in our explorations come to light during project development, additional exploration, testing and analysis may be necessary; changes in project design and construction may also be necessary.

Our recommendations have been made in accordance with the principles and practices generally

employed by the geotechnical engineering profession. This is in lieu of all other warranties, express or implied.

Should conditions different from those assumed in this report come to light during project development, additional exploration, testing and analysis may be necessary; changes in project design and construction may also be necessary.

All earthwork and associated construction should be observed by our field representative, and tested where necessary, to compare the generalized site conditions assumed in this report with those found at the site at the time of construction, and to verify that construction complies with the intent of our recommendations.

Report prepared by:

FRIAR ASSOCIATES, INCORPORATED

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GEOTECHNICAL INVESTIGATION
AND LIQUEFACTION EVALUATION
PROPOSED INDUSTRIAL BUILDING
DOOLITTLE ROAD
SAN LEANDRO, CALIFORNIA

PROJECT 1822-2

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Appendix A

Key to Exploratory Boring Logs
and
Boring Logs

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Liquefaction Analysis Results

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Laboratory Test Results