Appendix E
Geotechnical Investigation Report

ESA

Geotechnical Investigation Report,
Crawford Canyon Park,
Northwest Corner of Newport Avenue
And Crawford Canyon Road,
Orange, California

Prepared For
HUNSAKER & ASSOCIATES IRVINE, INC.

November 6, 2020

GMU Project No. 20-188-00

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PROJECT: 20-188-00

ATTENTION: Mr. Vojta Safranek

SUBJECT: Geotechnical Investigation Report, Crawford Canyon Park
Northwest Corner of Newport Avenue and Crawford Canyon Road
City of Orange, California

Dear Mr. Safranek:

GMU is pleased to present this geotechnical report for the subject project, which summarizes our data, conclusions, and recommendations.

Please note that this report has not been prepared for the use by other parties or projects other than those named or described herein. This report may not contain sufficient information for other parties or other purposes.

We appreciate the opportunity to work on this project. Please do not hesitate to contact the undersigned if you have any questions regarding any aspect of this report.

Respectfully submitted,

Nadim Sunna, MS, QSP, PE 84197
Senior Engineer

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Addressee: Electronic copy

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INTRODUCTION

PURPOSE

This report presents the results of our geotechnical investigation for the proposed development of the Crawford Canyon Park located on the northwest corner of Newport Avenue and Crawford Canyon Road, in the City of Orange, California.

SCOPE

The scope of our geotechnical investigation consist of the following:

1. Staked nine (9) hollow stem auger drill holes, coordinated with Hunsaker, and contacted Utility Underground Service Alert (USA/Dig Alert) in order to provide advance notification of the 9 subsurface drill holes planned within the park area.

2. Performed a field subsurface exploration program consisting of advancing: two (2) hollow-stem-auger borings to a depth of 21.5 feet below the existing grade, one (1) drill hole to a depth of 26.5 feet below the existing grade, four (4) drill holes a to a depth of 11.5 feet below the existing grade and two (2) drill holes to a depth of 3 and 5 feet below the existing grade for the purpose of performing infiltration testing. Logged the drill holes and obtained bulk and drive soil samples for geotechnical laboratory testing.

3. Performed laboratory testing on soil samples obtained from the drill holes. Testing included moisture and density, particle size, Atterberg Limits, expansion, chemical, compaction, direct shear strength, and R-value tests.

4. Interpreted and evaluated the acquired field and laboratory data to perform geotechnical engineering design which included settlement analysis, bearing capacity and associated settlement, pavement design, and seismic parameters in accordance with the 2019 California Building Code (CBC).

5. Prepared and distributed this formal geotechnical foundation report containing our final geotechnical conclusions and recommendations to support the main project submittal and permitting process.

LOCATION

The site is located on the northwest corner of Newport Avenue and Crawford Canyon Road in the City of Orange, California. The site is bound by Newport Avenue on the south, existing single family residences on the north and west, and Crawford Canyon Road on the east. The general location of the project site is shown on Plate 1.

PROPOSED IMPROVEMENTS

Based on our review of the provided conceptual design plans, we understand that the proposed site improvements will consist of the following:

- New asphalt-concrete parking lot
- New storm water basin
- 8-foot wide walkways
- 5-foot wide trails
- Picnic tables and benches
- Exercise station
- Pedestrian bridges
- Various play areas
- Retaining wall in order to create a level area for the new parking lot

As part of the grading for the proposed improvements, cuts and fills on the order of 8 feet will be performed and 2H:1V slopes of up to about 8 feet in maximum height are planned to be constructed at various locations throughout the park area.

SUBSURFACE EXPLORATION

GMU conducted a subsurface exploration program to evaluate the soil conditions below the proposed park features, parking areas, retaining wall and infiltration locations. A total of nine (9) hollow-stem-auger, truck-mounted drill holes were excavated to a maximum depth of 26.5 feet below the existing grade. The drill hole locations are shown on Plate 2 – Geotechnical Map. Drill hole logs are contained in Appendix A. The drill holes were logged by our Staff Engineer, and samples were collected in each of the drill holes for laboratory testing.

LABORATORY TESTING

Laboratory testing for the subject investigation was performed to characterize moisture and density, particle size distribution, Atterberg Limits, expansion index, maximum density, corrosion, direct shear, and R-value. The results of our laboratory testing are summarized on Table B-1 and included within Appendix B – Laboratory Testing.

GEOLOGIC FINDINGS

REGIONAL GEOLOGIC SETTING

Based on our site investigation and according to the Dibble Geologic Map, the project site is underlain by alluvium deposits (Qal) that are typically comprised of sands and clays.

SUBSURFACE MATERIALS

Artificial Fill (Qaf)

Artificial fill soils were encountered in majority of the excavations at the site. The fills were encountered to a maximum depth of 5 feet below the existing grade and generally consists of yellow and dark brown, damp to moist, firm to stiff, sandy clays.

Alluvium (Qal)

Alluvium underlay the artificial fill to the maximum depth of the exploratory drill holes. The alluvium consists of brown to dark gray brown to yellow brown, damp to moist, medium dense to very dense, sands and firm to stiff clays.

GROUNDWATER

Groundwater was not observed during our exploration to a maximum depth of 26.5 feet below the existing grade. Groundwater conditions may vary across the site due to stratigraphic and hydrologic conditions and may change over time as a consequence of seasonal and meteorological fluctuations, or activities by humans at this site and nearby sites. However, based on the above findings, groundwater is unlikely to impact the proposed development.

GEOLOGIC HAZARDS

FAULTING AND SEISMICITY

The site is not located within an Alquist-Priolo Earthquake Fault Zone, and no known active faults are shown on the reviewed geologic maps crossing the site, however, the site is located in the seismically active region of Southern California. The nearest known active faults are the San Joaquin Hills and Elsinore fault systems, which are located approximately 6.3 and 7.9 miles from the site, respectively, and capable of generating a maximum earthquake magnitude (Mw) of 7.1 and 7.9, respectively.

Given the proximity of the site to these and numerous other active and potentially active faults, the site will likely be subject to earthquake ground motions in the future. A site PGA_M of 0.64g was calculated for the site in conformance with the 2019 CBC. This PGA_M is primarily dominated by earthquakes with a mean magnitude of 6.6 at a mean distance of 10 miles from the site using the USGS 2014 Interactive Deaggregation website.

LANDSLIDES

Based on our review of available geologic maps, literature, topographic maps, aerial photographs, and our subsurface evaluation, no landslides or related features underlie or are adjacent to the subject site.

TSUNAMI, SEICHE, AND FLOODING

The site is not located on any State of California Tsunami Inundation Map for Emergency Planning. The potential for the site to be adversely impacted by earthquake-induced tsunamis is considered to be negligible because the site is located several miles inland from the Pacific Ocean coast at an elevation exceeding the maximum height of potential tsunami inundation.

The potential for the site to be adversely impacted by earthquake-induced seiches is considered to be negligible due to the lack of any significant enclosed bodies of water located in the vicinity of the site.

According to the County of Orange FEMA Flood Insurance Rate Map, majority of the site is located with an Area of Minimal Flood Hazard (Zone X), however, the southwester side of the site is located within “Zone”, an area of 0.2% annual chance flood, 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile, and protected by levees from 1% annual chance flood. The potential for the site to be adversely impacted by significant flooding is considered low.

GEOTECHNICAL ENGINEERING FINDINGS

SOIL EXPANSION

Based on our evaluation, experience with similar material types, the soils encountered near the ground surface at the site exhibit a low to medium expansion potential. The recommendations provided in this report are based on a ***medium expansion potential.***

SOIL CORROSION

Based on laboratory test results for pH, soluble chlorides, sulfate, and minimum resistivity of the site soils obtained during our subsurface investigation, the on-site soils should be considered to have the following:

- A negligible sulfate exposure to concrete per ACI 318-14, Table 19.3.1.1
- A low minimum resistivity indicating conditions that are severely corrosive to ferrous metals.
- Elevated chlorides levels (severely corrosive to ferrous metals).

The laboratory testing program performed for this project does not address the potential for corrosion to copper piping. In this regard, a corrosion engineer should be consulted to perform more detailed testing and develop appropriate mitigation measures (if necessary). The above discussion is provided for general guidance in regards to the corrosiveness of the on-site soils to typical metal structures used for construction. Detailed corrosion testing and recommendations for protecting buried ferrous metal and/or copper elements are beyond our purview. If detailed recommendations are required, a corrosion engineer should be consulted to develop appropriate mitigation measures.

SETTLEMENT

Based on the remedial and design at the site, long-term settlements are expected to be less than an inch, with a long-term differential settlement of approximately ½ of an inch over a span of 40 feet.

PRELIMINARY INFILTRATION TESTING

Two (2) preliminary infiltration tests were performed in general conformance with the County of Orange Technical Guidance Document (TGD). The infiltrations drill holes were excavated to depths ranging from 3 and 5 feet below the existing grade using a hollow-stem-auger, truck-mounted drill rig. At the completion of the testing, we have determined the unfactored observed infiltration rates as shown on Table 1 below. In addition, we have determined the geotechnical factor of safety in accordance with Section A of SOCTGD Worksheet 3 as shown on Table 2 below.

Table 1: Calculated Infiltration Rates*

Drill Hole	Depth Below Finish Grade (feet)	Infiltration Rate* (inch/hour)
DH-5	5.0	1.35
DH-6	5.0	0.67

**Rates do not incorporate a factor of safety.*

Table 2: Worksheet 3 Geotechnical Factor of Safety

Factor Category		Factor Description	Assigned Weight (w)	Factor Value (v)	Product (p) P = w x v
A	Suitability Assessment	Soil assessment methods	0.25	2	0.50
		Predominant soil texture	0.25	2	0.50
		Site soil variability	0.25	2	0.50
		Depth to groundwater / impervious layer	0.25	1	0.25
		Actual Suitability Assessment Safety Factor, S_A			1.75
		Minimum Suitability Assessment Safety Factor, S_A			2

Final determination of infiltration feasibility should be determined by the project civil engineer after applying all the necessary factor of safety in accordance with Worksheet 3.

We note that infiltration is deemed feasible when the design infiltration rates meet and exceeds the minimum infiltration rate of 0.3 inches per hour in accordance with the SOC TGD Manual.

The preliminary infiltration test hole locations are shown on Plate 2 - Geotechnical Map. The results of the infiltration testing are contained in Appendix C of this report.

EXCAVATION CHARACTERISTICS

Rippability

Based on our site exploration, it is expected that the soil materials underlying the site can be excavated with scrapers and other conventional grading equipment.

CONCLUSIONS

Based on our geotechnical findings, the following is a summary of our conclusions:

1. The project area is not underlain by any known active faults.

2. Groundwater is not expected to be encountered and is not anticipated to have a significant impact on the proposed development.

3. Based on the planned slopes configuration (i.e., 2H:1V) and the corrective grading provided in this report, we expect the slopes to be surficially and grossly stable.

4. Different settlement at the site is expected to approximately ½-inch over a horizontal distance of 40 feet.

5. The proposed miscellaneous structures, lightly loaded bridges, and retaining walls may be supported on a shallow foundation system underlain by engineered fill.

6. Site soils within the at-grade foundation influence zone are anticipated to have a low to medium expansion potential based on our recent laboratory test results and local experience. Recommendations for the proposed developments are based on a "medium" expansive condition.

7. Corrosion testing indicates that the on-site soils have a negligible sulfate exposure and are severely corrosive to buried ferrous metals and reinforcing steel. Consequently, any metal exposed to the soil shall be protected.

RECOMMENDATIONS

GENERAL SITE PREPARATION AND GRADING

General

The following recommendations pertain to any required grading associated with the proposed improvements and corrective grading needed to support the proposed improvements. All site preparation and grading should be performed in accordance with the County of Orange grading code requirements and the recommendations presented in this report.

Clearing and Grubbing

All significant organic material such as weeds, brush, tree branches, or roots, or construction debris such as old irrigation lines, asphalt concrete, and other decomposable material should be removed from the area to be graded. No rock or broken concrete greater than 6 inches in diameter should be utilized in the fills.

Corrective Grading

Corrective grading is needed at the site to create a firm and workable platform for construction of the proposed developments such as new bridge foundations, retaining wall foundations, parking lot pavement, site hardscape and miscellaneous lightly loaded structures.

It should be noted that the recommendations provided herein are based on our subsurface exploration and knowledge of the geologic conditions at the site. Actual removals may vary in configuration and volume based on observations of geologic materials and conditions encountered during grading. The bottom of all remedial grading removals should be observed by a GMU representative to verify the suitability of in-place soil prior to performing processing and fill placement. Corrective grading recommendations are outlined below:

General:

- The upper 2 feet of soil materials at the site, in areas supporting foundations should be removed to expose dense of firm, native alluvial soils. In areas supporting pavement and hardscape improvements removals may be reduced to 1 foot.
- If loose soil materials are found at depths greater than the proposed remedial grading, then additional removals/ over-excavation may be needed, as determined by a representative of GMU.

Bridge Foundations: Grading recommendations for support of the new bridge foundations should consist of the following:

- Bridge foundations are to be supported by at least 2 feet of engineered fill.
- If the general site removals of 2 feet does not provide for a minimum of 2 feet of engineered fill below the foundation, over-excavation to a depth of at least 2 feet below the bottom of the footing is required.
- The materials exposed at the bottom of all removals and over-excavation should be approved by a representative of GMU.

Retaining Walls and Miscellaneous Structures: Grading recommendations for support of the new retaining walls/site walls and miscellaneous structure foundations should consist of the following:

- The retaining, site wall and miscellaneous footings should be supported by at least 2 feet of engineered fill except for pole foundations, which may be founded on competent alluvial soils.
- If the general site removals of 2 feet does not provide for a minimum of 2 feet of engineered fill below the foundation, over-excavation to a depth of at least 2 feet below the bottom of the footing is required.

- The materials exposed at the bottom of all removals and over-excavation should be approved by a representative of GMU.

Flatwork and Pavement Areas: Grading recommendations for the support of the asphalt and concrete pavement and flatwork improvements should consist of the following:

- The areas below the proposed improvements should be removed to a depth of at least 12 inches below existing grade or subgrade, whichever is deeper, to provide for at least 12 inches of engineered fill under the flatwork and pavement improvements.
- The removal or over-excavation bottom should be approved by a representative of GMU.

Processing and Fill Placement

- The bottom of the excavation should then be scarified to a depth of at least 6 inches, moisture conditioned to 3% above optimum moisture content, and compacted to at least 90% relative compaction.
- Onsite soil materials may be used to backfill the corrective grading excavations and achieve the planned grade elevation.
- All fill material should be placed in 6- to- 8-inch-thick lifts, moisture conditioned to at least 3% above optimum moisture content, blended to achieve uniform moisture content and compacted to achieve 90% relative compaction.
- No rock or broken concrete greater than 6 inches in diameter should be utilized in the fills.
- Where existing ground surfaces are at 5:1 or steeper benching in accordance with Plate 5 should be performed

Temporary Excavations

Temporary excavations for demolitions, earthwork, footings, and utility trenches are expected. We anticipate that unsurcharged excavations with vertical side slopes less than 4 feet high will generally be stable. Our recommendations for temporary excavations are as follows:

- Temporary, unsurcharged excavation sides over 4 feet in height should be sloped no steeper than an inclination provided by OSHA for a Type B soil.

- Where sloped excavations are created, the tops of the slopes should be barricaded so that vehicles and storage loads do no encroach within 10 feet of the tops of the excavated slopes. A greater setback may be necessary when considering heavy vehicles, such as concrete trucks and cranes. GMU should be advised of such heavy vehicle loadings so that specific setback requirements can be established.
- If the temporary construction slopes are to be maintained during the rainy season, berms are recommended to be graded along the tops of the slopes in order to prevent runoff water from entering the excavation and eroding the slope faces.

Our temporary excavation recommendations are provided only as **minimum** guidelines. All work associated with temporary excavations should meet the minimal requirements as set forth by CAL-OSHA. Temporary slope construction, maintenance, and safety are the responsibility of the contractor.

STRUCTURE SEISMIC DESIGN

No active or potentially active faults are known to cross the site, therefore, the potential for primary ground rupture due to faulting on-site is very low. However, the site will likely be subject to seismic shaking at some time in the future.

Based on our field exploration and the site soil profile, the site should be designated as Site Class D based on the measured Standard Penetration Resistance within drill holes. The seismic design coefficients based on ASCE 7-16 and 2019 CBC are listed in Table 3 below.

Table 3: 2019 CBC and ASCE 7-16 Seismic Design Parameters
(To be utilized as per the requirements of Section 11.4.8 of ASCE 7-16)

Seismic Item	Design Value	2016 ASCE 7-16 or 2019 CBC Reference
Site Class based on soil profile (ASCE 7-16 Table 20.3-1)	D[(a)]	ASCE 7-16 Table 20.3-1
Short Period Spectral Acceleration S_s	1.371[(a)]	CBC Figures 1613.2.1 (1-8)
1-sec. Period Spectral Acceleration S_1	0.488[(a)]	CBC Figures 1613.2.1 (1-8)
Site Coefficient F_a (2019 CBC Table 1613.2.3(1))	1.200[(a)]	CBC Table 1613.2.3 (1)
Site Coefficient F_v (2019 CBC Table 1613.2.3(2))	1.812[(b)]	CBC Table 1613.2.3 (2)
Short Period MCE* Spectral Acceleration S_{MS} $S_{MS} = F_a S_s$	1.645[(a)]	CBC Equation 16-36
1-sec. Period MCE Spectral Acceleration S_{M1} $S_{M1} = F_v S_1$	0.884[(b)]	CBC Equation 16-37
Short Period Design Spectral Acceleration S_{DS} $S_{DS} = 2/3 S_{Ms}$	1.097 [(a)]	CBC Equation 16-38
1-sec. Period Design Spectral Acceleration S_{D1} $S_{D1} = 2/3 S_{M1}$	0.590[(b)]	CBC Equation 16-39
Short Period Transition Period T_S (sec) $T_S = S_{D1}/S_{DS}$	0.538[(b)]	ASCE 7-16 Section 11.4.6
Long Period Transition Period Tl (sec)	8[(b)]	ASCE 7-16 Figures 22-14 to 22-17
MCE[(c)] Peak Ground Acceleration (PGA)	0.531[(a)]	ASCE 7-16 Figures 22-9 to 22-13
Site Coefficient F_{PGA} (ASCE 7-16 Table 11.8-1)	1.200[(a)]	ASCE 7-16 Table 11.8-1
Modified MCE[(c)] Peak Ground Acceleration (PGA_M)	0.637[(a)]	ASCE 7-16 Equation 11.8-1

(a) Design Values Obtained from USGS Earthquake Hazards Program website that are based on the ASCE-7-16 and 2019 CBC and site coordinates of N33.7747000º and W117.788512º.
(b) Design Values Determined per ASCE Table 11.4-2 and CBC Equations 16-36 through 16-39.
(c) MCE: Maximum Considered Earthquake.

Since the Site Class is designated as D and the S_1 value is greater than or equal to 0.2, the 2019 CBC requires either a site-specific seismic hazard analysis per Section 21.2 of ASCE 7-16 or the application of Exception 2 of Section 11.4.8 of ASCE 7-16. The project structural engineer should apply all requirements of Section 11.4.8 of ASCE 7-16 to determine if increases to the seismic response coefficient (i.e. increases to the loading of the structure) are required.

Per the 2019 CBC and ASCE 7-16, the Design Earthquake peak ground acceleration (PGA_D) may be assumed to be equivalent to $S_{DS}/2.5$; therefore, for the subject site, a PGA_D value of 0.35g (0.866g/2.5) should be used.

It should be recognized that much of southern California is subject to some level of damaging ground shaking as a result of movement along the major active (and potentially active) fault zones that characterize this region. Design utilizing the 2019 CBC is not meant to completely protect against damage or loss of function. Therefore, the preceding parameters should be considered as minimum design criteria.

BRIDGE FOUNDATION DESIGN AND CONSTRUCTION

General

The criteria contained in the following section may be used for the design and construction of the proposed bridge foundations. Foundation design parameters are presented below.

General Foundation Design Parameters

- Bearing Material: Minimum 2 feet of Engineered Fill
- Minimum Footing Size:
  - Width: 24 inches
  - Depth: 24 inches embedment below lowest adjacent soil grade (depth)
- Allowable Bearing Capacity: 2,000 psf for the minimum footing size given above.
  - May be increased by 100 psf for every footing width and 400 psf for every footing depth to a maximum allowable bearing pressure of 2,500 psf.
  - Above value may be increased by 1/3 for temporary loads such as wind or seismic
- Lateral Foundation Resistance:
  - Allowable passive resistance: 250 psf/ft (disregard upper 6 inches, max 2,500 psf)
  - Allowable friction coefficient: 0.35
  - Above values may be combined without reduction and may be increased by 1/3 for temporary loads such as wind or seismic

RETAINING AND SITE WALL DESIGN AND CONSTRUCTION CRITERIA

The following criterion is considered applicable to the design and construction of retaining and site walls at the subject site. The design assumes a maximum 6-foot-high retaining wall (i.e., from top of footing to top of retaining portion of wall) with level backfill conditions. In addition, the design assumes the use of on-site select backfill in accordance with Plate 3 – Retaining Wall Construction Detail.

Foundation Design Parameters:

Minimum Foundation Width:	24 inches (retaining) 12 inches (free standing)
Minimum Foundation Depth:	Depth below lowest adjacent grade to bottom of footing: o 24 inches

Bearing Materials:	Minimum 2 feet of Engineered fill
Allowable Bearing Capacity:	2,000 psf for footing on level ground o 1/3 increase for wind or seismic conditions
Allowable Coefficient of Friction:	0.35
Unit Weight of Backfill:	125 pcf
Allowable Passive Earth Pressure:	250 psf/ft of depth (static) o Disregard upper 6 inches o Reduce passive by one-third when combined with friction in sliding resistance o 1/3 increase for seismic conditions

Wall Design Parameters:

Active Earth Pressure:	45 pcf – level backfill (Assumes the use of select soils in backfill zone)
Weight of Backfill:	125 pcf
Control/Construction Joints:	As a minimum, maximum spacing of 15 feet and at angle points
Waterproofing:	The back side of all retaining walls should be waterproofed down to the top of the foundation prior to placing subdrains or backfill. The design and selection of the waterproofing system is outside the scope of our report and is outside our purview.
Concrete:	See "Structural Concrete" section of this report.
Wall Backfill and Drainage:	See Retaining Wall Construction Detail Diagram and Notes (shown on Plate 3) for backfill and drainage requirements.

The unrestrained (active) values are applicable when the walls are designed and constructed as cantilevered walls allowing sufficient wall movement to mobilize active pressure conditions. This wall movement should not be less than 0.01 H (H = height of wall) for the unrestrained values to be applicable.

Provided that the retaining walls have a maximum height of less than 6 feet, the current 2016 CBC indicates that the incorporation of seismic earth pressures is not required.

POLE FOUNDATIONS

It is expected that the shade structures and light poles will be supported on pole foundations. As a minimum, the pole foundations should be at least 18 inches in diameter and at least 4 feet deep; however, the actual dimensions should be determined by the project structural engineer based on the following design parameters.

Bearing Materials. The pole foundations may bear into engineered fill soils or competent native soils approved by a representative from GMU.

Bearing Values. End-bearing capacity and skin friction may be combined to determine the allowable bearing capacities of the pole foundations. An allowable bearing pressure of 3,000 pounds per square foot (psf) may be used for pole foundations at least 18 inches in diameter and embedded a minimum of 4 feet below the lowest adjacent grade. A value of 200 pounds per square foot may be used to determine the skin friction between the concrete and surrounding soil.

Lateral Load Design. Lateral loads may be resisted by passive resistance within the adjacent earth materials. For passive resistance, an allowable passive earth pressure of 250 pounds per foot of pile diameter per foot of depth into competent bearing material may be used; however, passive resistance should be disregarded within the upper foot due to possible disturbance during drilling. The passive resistance value may be applied over an area equivalent to two pile diameters.

STRUCTURAL CONCRETE

Laboratory tests indicate that the onsite soils are classified as having a “negligible” sulfate exposure and “S0” sulfate exposure category per ACI 318-14, Table 19.3.1.1. However, due to the low to moderate soil resistivity and elevated chloride levels obtained from our test result, the on-site soil is severely corrosive to ferrous metals such as reinforcing steel. On this basis, we recommend that a Type II/V cement with a maximum water to cement ratio of 0.50 be used for structural elements (i.e., foundations, walls, etc.). Utilization of CBC moderate sulfate level requirements will also serve to reduce the permeability of the concrete and help minimize the potential of water and/or vapor transmission through the concrete. Wet curing of the concrete per ACI Publication 308 is also recommended.

Wet curing of the concrete per ACI Publication 308 is also recommended.

The aforementioned recommendations in regards to concrete are made from a soils perspective only. Final concrete mix design is beyond our purview. All applicable codes, ordinances, regulations, and guidelines should be followed in regard to the designing a durable concrete with respect to the potential for sulfate exposure from the on-site soils and/or changes in the environment.

FERROUS METAL CORROSION PROTECTION

The results of the laboratory chemical tests performed on a sample of soil collected within the site indicate that the on-site soils are severely corrosive to ferrous metals. Consequently, metal structures which will be in direct contact with the soil (i.e., underground metal conduits, pipelines, metal sign posts, etc.) and/or in close proximity to the soil (wrought iron fencing, etc.) may be subject to corrosion. The use of special coatings or cathodic protection around buried metal structures has been shown to be beneficial in reducing corrosion potential. Additional provisions will be required to address high chloride contents of the soil per the 2019 CBC to protect the concrete reinforcement. The laboratory testing program performed for this project does not address the potential for corrosion to copper piping. In this regard, a corrosion engineer should be consulted to perform more detailed testing and develop appropriate mitigation measures (if necessary).

The above discussion is provided for general guidance in regards to the corrosiveness of the on-site soils to typical metal structures used for construction. Detailed corrosion testing and recommendations for protecting buried ferrous metal and/or copper elements are beyond our purview. If detailed testing is required, a corrosion engineer should be consulted to perform the testing and develop appropriate mitigation measures.

SURFACE DRAINAGE

Surface drainage should be carefully controlled during and after grading to prevent ponding and uncontrolled runoff adjacent to the structures. Particular care will be required during grading to maintain slopes, swales, and other erosion control measures needed to direct runoff toward permanent surface drainage facilities. Positive drainage of at least 2% away from the perimeters of the structures and site pavements should be incorporated into the design. In addition, it is recommended that nuisance water be directed away from the perimeter of the structures by the use of area drains in adjacent landscape and flatwork areas and roof drains tied into the site storm drain system.

UTILITY TRENCH BACKFILL CONSIDERATIONS

General

New utility line pipelines should be backfilled with both select bedding materials beneath and around the pipes and compacted soil above the pipe bedding. Recommendations for the types of the materials to be used and the proper placement of these materials are provided in the following sections.

Pipe Bedding

The pipe bedding materials should extend from at least 6 inches below the pipes to at least 12 inches above the crown of the pipes. Pipe bedding should consist of either clean sand with a sand equivalent (SE) of at least 30 or crushed rock. If crushed rock is used, it should consist of ¾-inch crushed rock that conforms to Table 200-1.2 of the 2018 "Greenbook." Pipe bedding should also meet the minimum requirements of the County of Orange. If the requirements of the County are more stringent, they should take precedence over the geotechnical recommendations. Sufficient laboratory testing should be performed to verify the bedding meets the minimum requirements of the Greenbook.

Based on our subsurface exploration and knowledge of the onsite materials, the soils that will be excavated from the pipeline trenches will not meet the recommendations for pipe bedding materials; therefore, imported materials will be required for pipe bedding.

Granular pipe bedding material having a sand equivalent of 30 or greater should be properly placed in thicknesses not exceeding 3 feet, and then sufficiently jetted in place. With proper techniques, jetting is not expected to have an adverse impact on existing site soils.

Crushed rock, if used, should be capped with filter fabric (Mirafi 140N, or equivalent) to prevent the migration of fines into the rock.

Trench Backfill

All existing soil material within the limits of the pipeline alignment are considered suitable for use as trench backfill above the pipe bedding zone if care is taken to remove all significant organic and other decomposable debris, moisture condition the soil materials as necessary, and separate and selectively place and/or stockpile any inert materials larger than 6 inches in maximum diameter.

Imported soils are not anticipated for backfill since the on-site soils are suitable. However, if imported soils are used, the soils should consist of clean, granular materials with physical and chemical characteristics similar to those described herein for on-site soils. Any imported soils to be used as backfill should be evaluated and approved by GMU prior to placement.

Soils to be used as trench backfill should be moistened, dried, or blended as necessary to achieve a minimum of 3% over optimum moisture content for compaction, placed in loose lifts no greater than 8 inches thick, and mechanically compacted/densified to at least 90% relative compaction as determined by ASTM Test Method D 1557.

No rock or broken concrete greater than 6 inches in maximum diameter should be utilized in the trench backfills.

ASPHALT CONCRETE PAVEMENT THICKNESS RECOMMENDATIONS

Asphalt Pavement Design

Based on the R-value test results, as well as testing completed in the vicinity, an R-value of 26 was used for the design. Table 4 below provides recommended minimum thicknesses for asphalt concrete (AC) and aggregate base sections for two traffic indices.

Table 4: Recommended Minimum AC and Base Section Thicknesses

Location	R-Value	Traffic Index	Asphalt Concrete (in.)	Aggregate Base* (in.)
Driveways	26	5.5	4.0	5.5
Parking Stalls	26	4.0	4.0	4.0

* assumed R-Value = 78

Asphalt concrete pavement construction should be in accordance with the following recommendations:

- The planned pavement structural sections should consist of aggregate base materials (AB) and asphalt concrete materials (AC) of a type meeting the minimum Caltrans and City of Carlsbad requirements.
- The subgrade soils should be prepared in accordance with the ***Corrective Grading*** section of this report.
- The subgrade soils should unyielding and be check by a representative of GMU prior to placing the required AB section.
- The AB and AC should be compacted to at least 95% relative compaction.

CONCRETE FLATWORK DESIGN CONSIDERATIONS

We recommend that the subgrade for the subject concrete flatwork be moisture conditioned to 3% over optimum to a depth of 18 inches below finish grade and compacted to 90% relative compaction. The concrete for flatwork is considered non-structural and may be designed with concrete strengths that are determined by the engineer or designer responsible for these improvements. The concrete design should account for the elevated levels of chlorides within the onsite soils. Minimum recommendations are provided below:

- Cement Type: II/V
- Maximum Water Cement Ratio/ Concrete Strength:
  - No special requirements. W/C ratio and concrete strength should be selected by the engineer or designer balancing the chloride exposure (i.e., for flatwork only), durability, and project settlement as well as temperature and shrinkage stresses

- See Table 5 below for summary of flatwork recommendations:

Table 5: Concrete Flatwork Recommendations

Description	Subgrade Preparation (1)	Minimum Concrete Thickness	Reinforcement(3)	Joint Spacing (Max.)	Concrete Cement(4)
Concrete Paving (Patio, flatwork, sidewalk) (< 5 feet in width)	3% over optimum to 18 inches at 90% relative compaction	4 inches	1) No. 3 bars at 18" o.c. extend into thickened edge, 2) Thickened Edge: two horizontal No. 3 bar placed at the top and bottom 3) dowel into building and curb using 9-inch Speed Dowels @ 18"o.c	5 feet	Type II/V
Concrete Paving (Patio, flatwork, sidewalk) (> 5 feet in width)	3% over optimum to 18 inches at 90% relative compaction	4 inches	1) No. 3 bars at 18" o.c. extend into thickened edge, 2) Thickened Edge: two horizontal No. 3 bar placed at the top and bottom 3) dowel into building and curb using 9-inch Speed Dowels @ 18"o.c	8 feet	Type II/V

(1) The moisture content and compaction of the subgrade must be verified by the geotechnical consultant prior to placement of concrete/reinforcement.
(2) For pedestrian usages only, S.E. 30 sand may be used instead of Aggregate Base.
(3) Reinforcement to be placed in the middle of the recommended concrete section.
(4) Final concrete mix design to be supplied by others.

PLANTERS AND TREES

Where new trees or large shrubs are to be located in close proximity of new concrete flatwork, rigid moisture/root barriers should be placed around the perimeter of the flatwork to at least 2 feet in depth in order to offer protection to the adjacent flatwork against potential root and moisture damage. Existing mature trees near flatwork areas should also incorporate a rigid moisture/root barrier placed at least 2 feet in depth below the top of the flatwork.

PLAN REVIEW / GEOTECHNICAL TESTING DURING GRADING / FUTURE REPORT

Plan Review

GMU should review the final construction plans (grading and foundation plans) to confirm that they are consistent with our recommendations provided in this report.

Geotechnical Testing

Geotechnical observation and testing should be performed by the geotechnical engineer of record during the following stages of precise grading and construction:

- During site clearing and grubbing.
- During removal of any buried irrigation lines or other subsurface structures.
- During all phases of grading including over-excavation, temporary excavations, removals, scarification, ground preparation, moisture conditioning, proof-rolling, and placement and compaction of all fill materials.
- During grading for new foundations.
- During pavement and flatwork section placement and compaction.
- When any unusual conditions are encountered.

Future Report

If required, a report summarizing our construction observation/testing services will be prepared at project completion.

LIMITATIONS

All parties reviewing or utilizing this report should recognize that the findings, conclusions, and recommendations presented represent the results of our professional geological and geotechnical engineering efforts and judgments. Due to the inexact nature of the state of the art of these professions and the possible occurrence of undetected variables in subsurface conditions, we cannot guarantee that the conditions actually encountered during grading and site construction will be identical to those observed, sampled, and interpreted during our study, or that there are no unknown subsurface conditions which could have an adverse effect on the use of the property. We have exercised a degree of care comparable to the standard of practice presently maintained by other professionals in the fields of geotechnical engineering and engineering geology, and believe that our findings present a reasonably representative description of geotechnical conditions and their probable influence on the grading and use of the property.

Our conclusions and recommendations are based on the assumption that our firm will act as the geotechnical engineer of record during construction and grading of the project to observe the actual conditions exposed, to verify our design concepts and the grading contractor's general compliance with the project geotechnical specifications, and to provide our revised conclusions and recommendations should subsurface conditions differ significantly from those used as the basis for our conclusions and recommendations presented in this report. Since our conclusions and recommendations are based on a limited amount of current and previous geotechnical exploration and analysis, all parties should recognize the need for possible revisions to our conclusions and recommendations during grading of the project.

It should be further noted that the recommendations presented herein are intended solely to minimize the effects of post-construction soil movements. Consequently, minor cracking and/or distortion of all on-site improvements should be anticipated.

This report has not been prepared for the use by other parties or projects other than those named or described herein. This report may not contain sufficient information for other parties or other purposes.

CLOSURE

If you have any questions concerning our findings or recommendations, please do not hesitate to contact us and we will be happy to discuss them with you. The Plates and Appendices that complete this report are listed in the Table of Contents.

Respectfully submitted,

GMU GEOTECHNICAL, INC.

Nadim Sunna, M.Sc., P.E. 84197
Senior Engineer

Alan B. Mutchnick, PG, CEG 1789
Associate Engineering Geologist

Ns/20-188-00 (11-6-2020)

REFERENCES

SITE-SPECIFIC REFERENCES

(1) Site Plan, OC Parks – Crawford Park, prepared by Hunsaker and Associates Irvine, Inc., dated October 16, 2020.

TECHNICAL REFERENCES

California Building Standards Commission and International Conference of Building Officials, 2019, *2019 California Building Code.*

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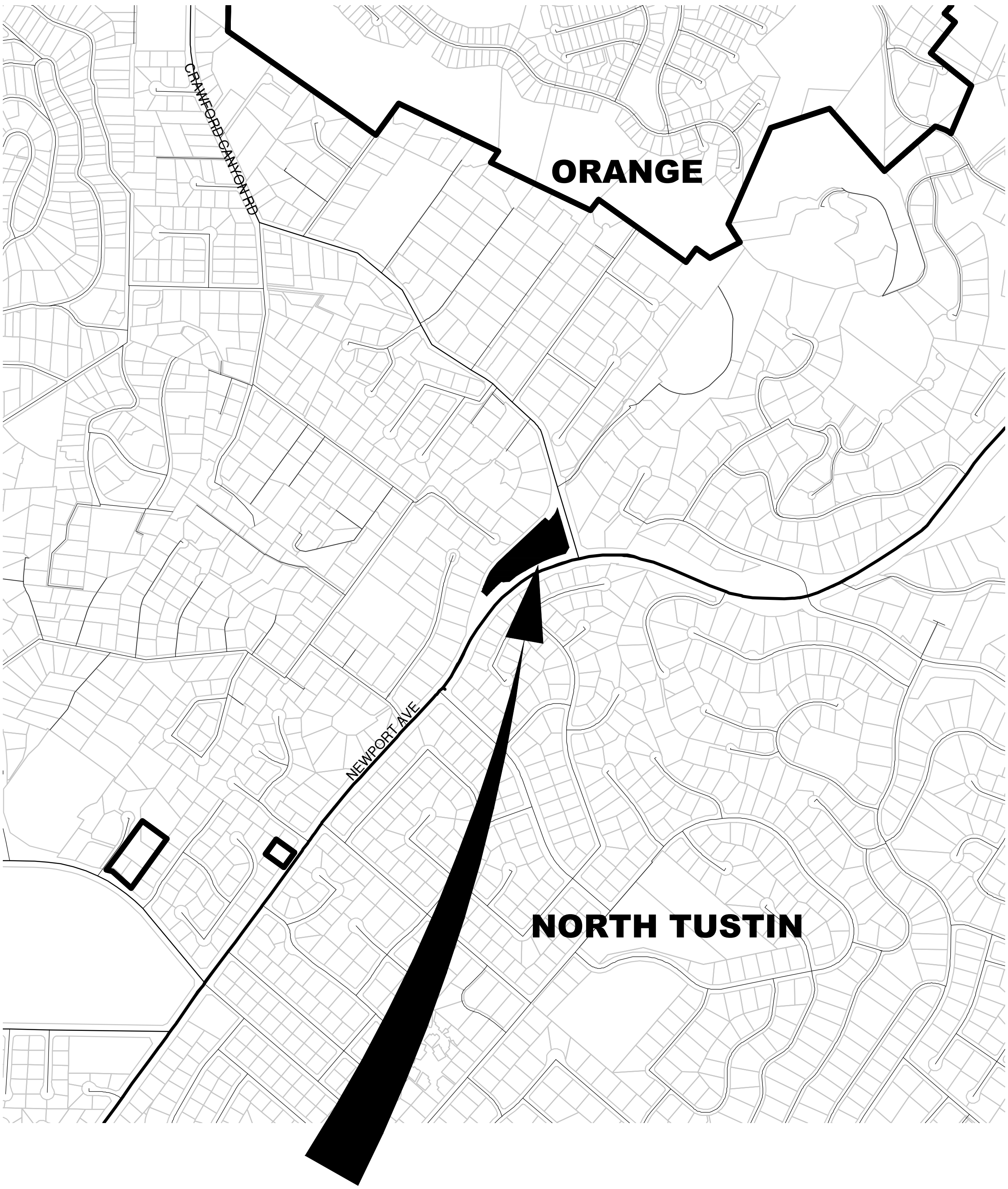
U.S. Geological Survey, 2013a, 2014 Interactive De-aggregations Program; web site address: http://geohazards.usgs.gov/deaggint/2008/.

U.S. Geological Survey, 2013b, U.S. Seismic Design Maps, web site address: http://earthquake.usgs.gov/hazards/designmaps/usdesign.php.



CRAWFORD PARK
NEWPORT AVE & CRAWFORD CANYON RD
NORTH TUSTIN, CA

0 1000'

Location Map

GMU

Date:	November 6, 2020	Plate 1
Project No.:	20-188-00	

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PREPARED FOR:

OCparks

PREPARED BY:

HUNSAKER & ASSOCIATES
IRVINE, INC.
PLANNING • ENGINEERING • SURVEYING
Three Hughes • Irvine, CA 92618 • PH: (949) 583-1010 • FX: (949) 583-0759

GEOTECHNICAL MAP

Date:	November 6, 2020	Plate
Project No.:	20-188-00	2

OC PARKS
CRAWFORD PARK
SITE PLAN

October 16, 2020

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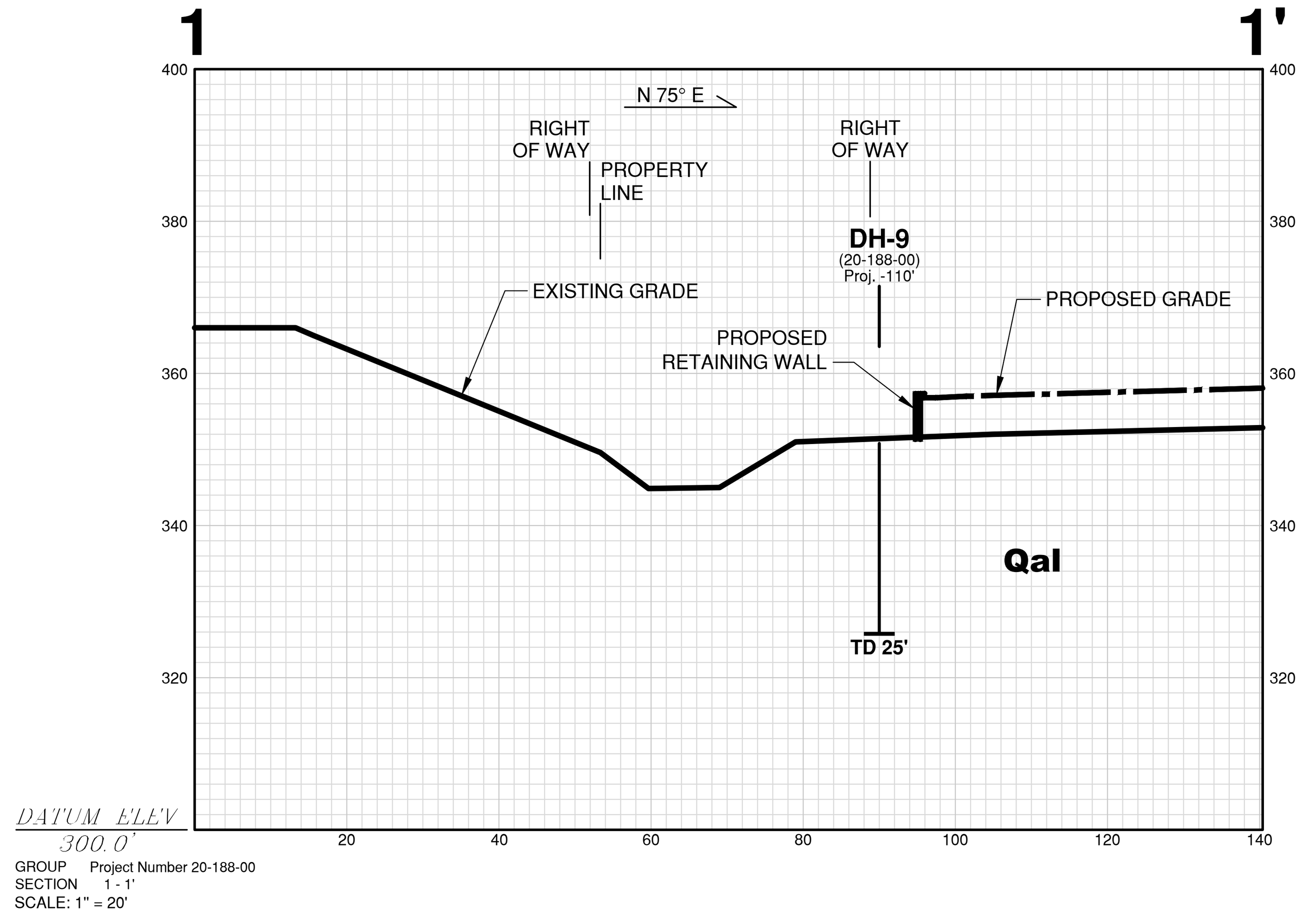

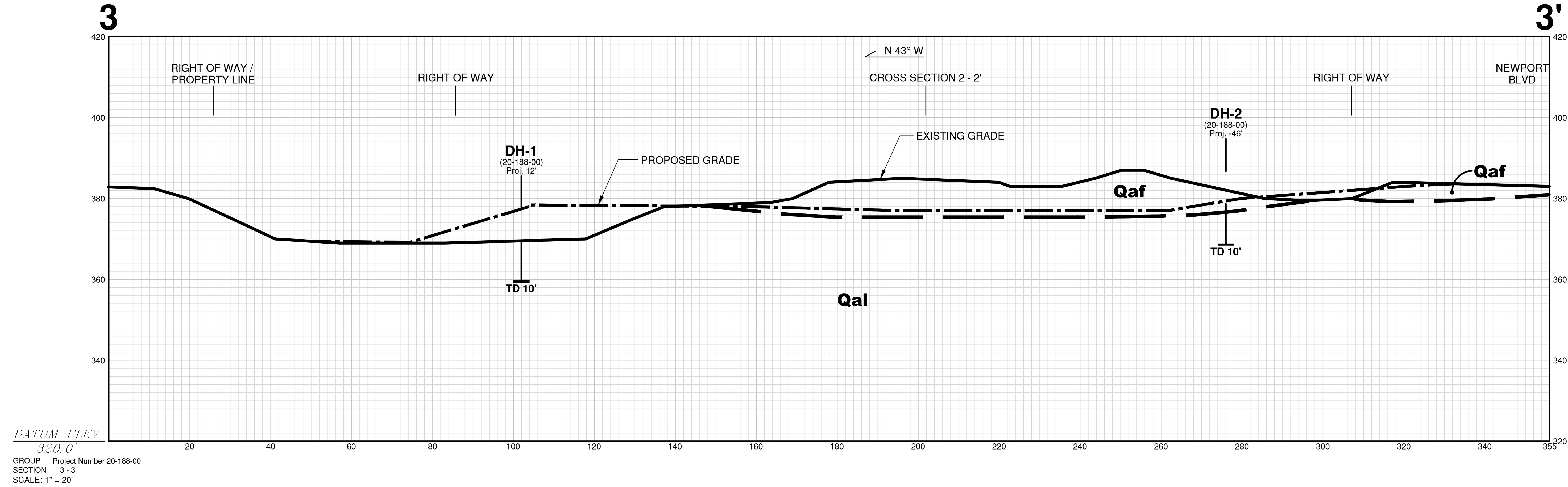

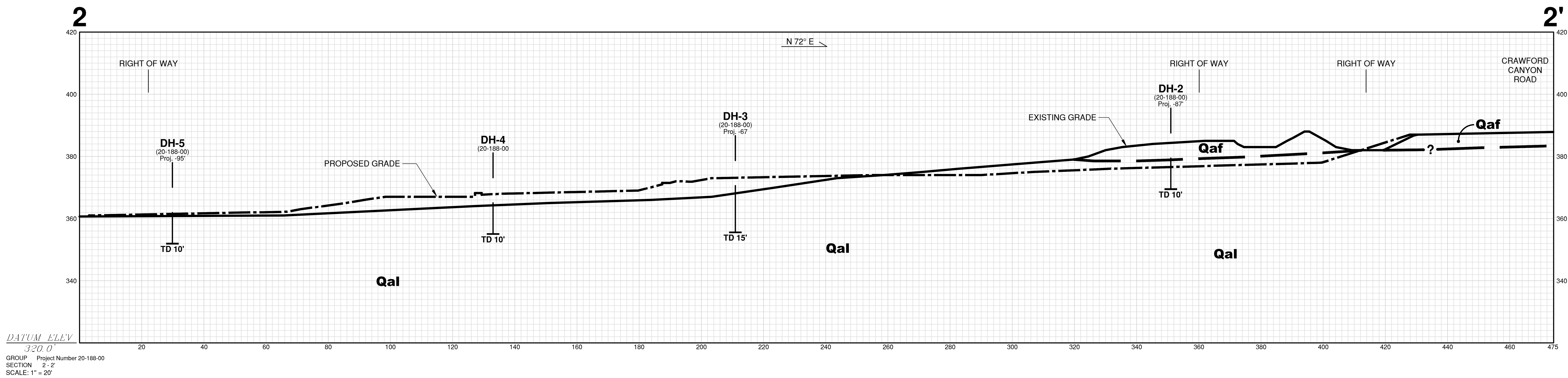

0 20' 40'

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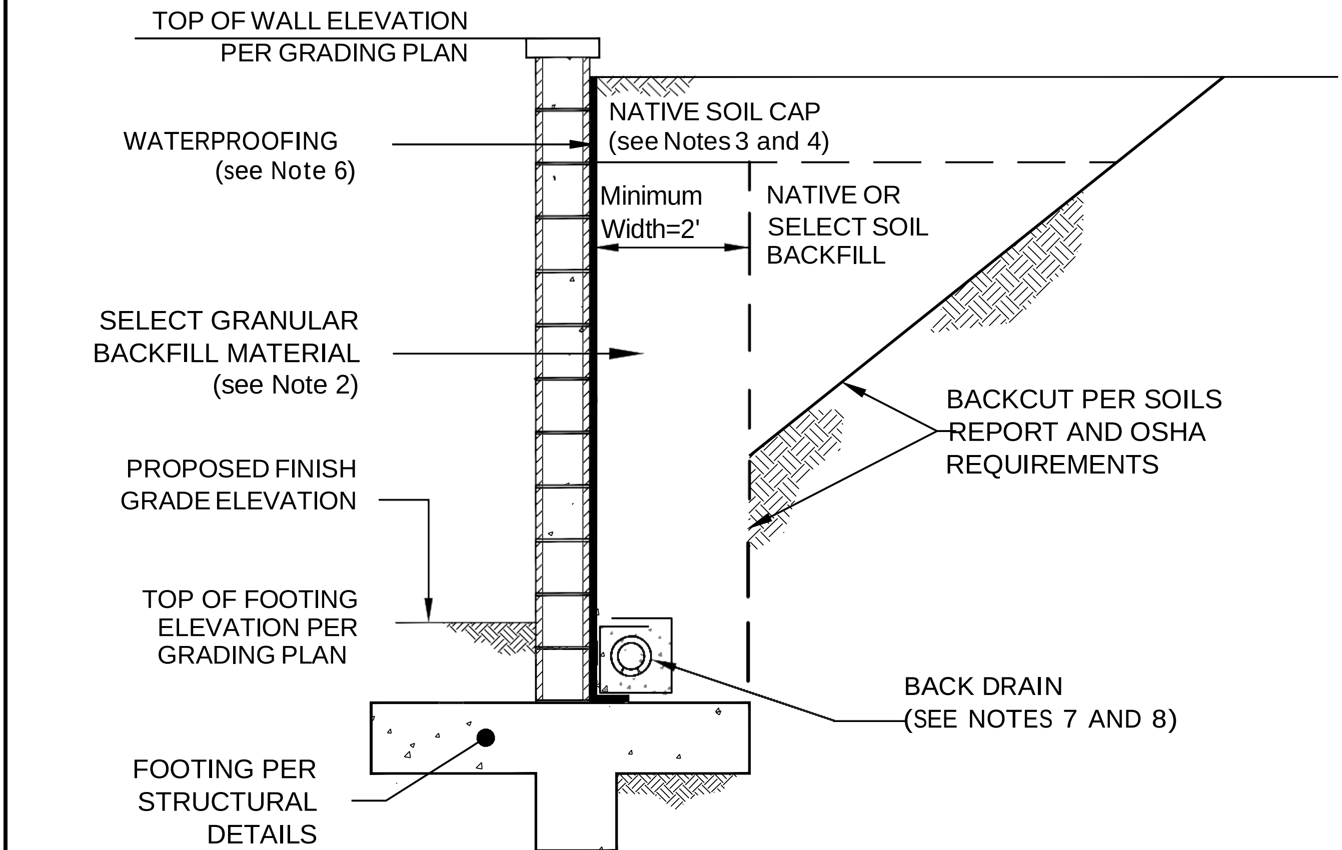
Geotechnical Sections

GMU

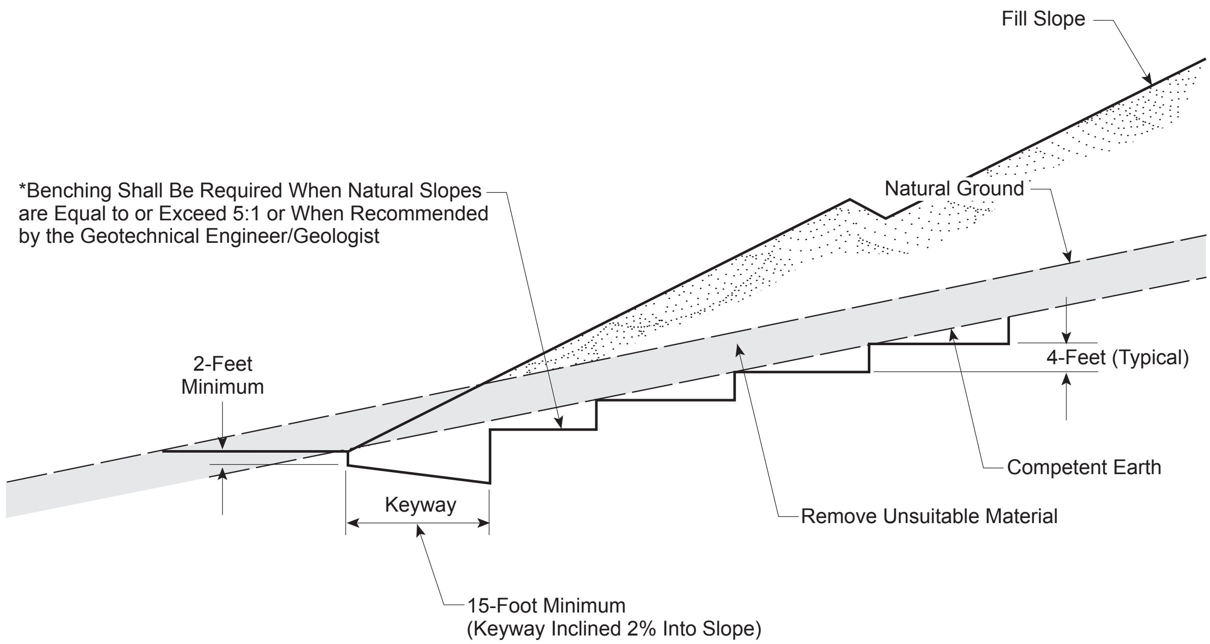
Date:	November 6, 2020	Plate 3
Project No.:	20-188-00	



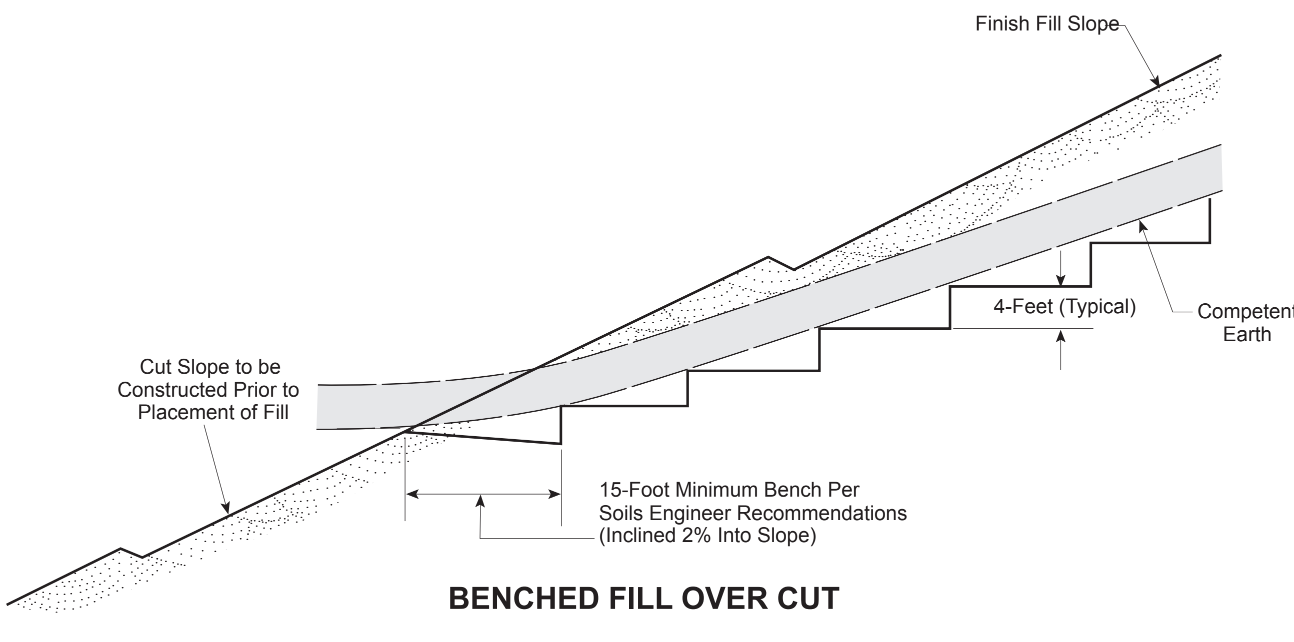
RETAINING WALL DETAIL
NOT TO SCALE

1. FINAL DETERMINATION OF THE MATERIAL TO BE USED FOR BACKFILL SHALL BE MADE BY GMU.
2. ALL SELECT BACKFILL TO WITHIN 1 TO 2 FEET OF FINAL GRADE SHOULD CONSIST OF FREE-DRAINING GRANULAR MATERIAL (I.E. SE 30 SAND, PEA GRAVEL, OR CRUSHED ROCK). CRUSHED ROCK, IF USED, SHOULD BE WRAPPED IN FILTER FABRIC (MIRAFI 140N OR EQUIVALENT) TO MINIMIZE THE POTENTIAL FOR MIGRATION OF FINES INTO THE ROCK. THE SELECT BACKFILL SHOULD BE MOISTURE CONDITIONED TO ACHIEVE OVER OPTIMUM MOISTURE CONTENT PER THE SOILS REPORT AND COMPACTED TO AT LEAST 90% RELATIVE COMPACTION AS DETERMINED BY ASTM TEST METHOD D 1557.
3. FINE-GRAINED NATIVE SOILS SHOULD BE USED TO CAP THE SELECT BACKFILL ZONE.
4. ALL NATIVE OR SELECT SOIL WALL BACKFILL SHOULD BE MOISTURE CONDITIONED AS NECESSARY TO OVER OPTIMUM MOISTURE CONTENT PER THE SOILS REPORT AND COMPACTED TO AT LEAST 90% RELATIVE COMPACTION AS DETERMINED BY ASTM TEST METHOD D 1557.
5. THE BACKSIDE OF THE WALLS SHOULD BE WATERPROOFED DOWN TO AND ACROSS THE TOP OF THE FOOTING. THE DESIGN AND SELECTION OF THE WATERPROOFING SYSTEM IS OUTSIDE OF THE PURVIEW OF GMU.
6. THE WATERPROOFING SYSTEM AND ANY DRAIN BOARDS SHOULD BE PROTECTED FROM DAMAGE BY CONSTRUCTION ACTIVITIES. THE TOP EDGE OF THE WATERPROOFING AND ANY DRAIN BOARDS SHOULD BE PROPERLY ADHERED TO THE WALL AND SEALED TO PREVENT THE POSSIBLE ACCUMULATION OF DEBRIS BETWEEN THE DRAINAGE/WATERPROOFING SYSTEM AND THE WALL.
7. THE BACKDRAIN SYSTEM SHOULD CONSIST OF 4" PERFORATED PIPE SURROUNDED BY AT LEAST ONE CUBIC FOOT OF 3/4"-1.5" OPEN GRADED GRAVEL WRAPPED IN MIRAFI 140N FILTER FABRIC (OR EQUIVALENT). THE PERFORATED PIPE SHOULD CONSIST OF SDR-35 OR SCHEDULE 40 PVC PIPE (OR APPROVED EQUIVALENT) LAID ON AT LEAST 2" OF CRUSHED ROCK WITH THE PERFORATIONS LAID DOWN. THE BACKDRAIN GRADIENT SHOULD NOT BE LESS THAN 1% WHEN POSSIBLE. THE PERFORATED PIPE SHOULD OUTLET INTO AREA DRAINS OR OTHER SUITABLE OUTLET POINTS AT RUNS OF 200 FEET OR LESS, IF PRACTICAL. IF THE BACKDRAINS CANNOT BE OUTLETED BY GRAVITY FLOW, A SUMP PUMP SYSTEM WILL NEED TO BE DESIGNED AND CONSTRUCTED. REDUNDANT BACK-UP PUMPS OR COMPONENTS ARE RECOMMENDED. DESIGN OF THIS SYSTEM IS OUTSIDE OF THE PURVIEW OF GMU.
8. THE TIE-IN LOCATIONS FOR BACKDRAIN OUTLETS SHOULD BE SHOWN ON THE PRECISE GRADING, SITE WALL, AND/OR LANDSCAPE PLANS.

GMU	RETAINING WALL CONSTRUCTION DETAIL	PLATE 4



BENCHED FILL OVER NATURAL



BENCHED FILL OVER CUT

GMU

TYPICAL BENCHING AND KEYWAY

Plate

5

APPENDIX A

Geotechnical Exploration Procedures and Logs

APPENDIX A

GMU GEOTECHNICAL EXPLORATION PROCEDURES AND LOGS

Our exploration at the subject site consisted of nine (9) drill holes. The estimated locations of the explorations are shown on Plate 2 – Geotechnical Map. Our drill holes were logged by a Staff Engineer, and drive, bulk, and SPT samples of the excavated soils were collected. "Undisturbed" samples were taken using a 3.0-inch thin walled, outside-diameter drive sampler which contains a 2.416-inch-diameter brass sample sleeve 6 inches in length. Standard penetration testing (SPT) with a 2.0-inch outside diameter split spoon sampler without liners was performed in the borings during advancement. Blow counts recorded during sampling from the drive and SPT sampler are shown on the drill hole logs. The logs of each drill hole are contained in this Appendix A, and the Legend to Logs is presented as Plate A-1 and A-2.

The geologic and engineering field descriptions and classifications that appear on these logs are prepared according to Corps of Engineers and Bureau of Reclamation standards. Major soil classifications are prepared according to the Unified Soil Classification System as modified by ASTM Standard No. 2487. Since the descriptions and classifications that appear on the Log of Drill hole are intended to be that which most accurately describe a given interval of a drill hole (frequently an interval of several feet), discrepancies do occur in the Unified Soil Classification System nomenclature between that interval and a particular sample in that interval. For example, an 8-foot-thick interval in a log may be identified as silty sand (SM) while one sample taken within the interval may have individually been identified as sandy silt (ML). This discrepancy is frequently allowed to remain to emphasize the occurrence of local textural variations in the interval.

MAJOR DIVISIONS			Group Letter	Symbol	TYPICAL NAMES
COARSE-GRAINED SOILS More Than 50% Retained On No.200 Sieve Based on The Material Passing The 3-Inch (75mm) Sieve. Reference: ASTM Standard D2487	**GRAVELS** 50% or More of Coarse Fraction Retained on No.4 Sieve	Clean Gravels	GW		Well Graded Gravels and Gravel-Sand Mixtures, Little or No Fines.
			GP		Poorly Graded Gravels and Gravel-Sand Mixtures Little or No Fines.
		Gravels With Fines	GM		Silty Gravels, Gravel-Sand-Silt Mixtures.
			GC		Clayey Gravels, Gravel-Sand-Clay Mixtures.
	SANDS More Than 50% of Coarse Fraction Passes No.4 Sieve	Clean Sands	SW		Well Graded Sands and Gravelly Sands, Little or No Fines.
			SP		Poorly Graded Sands and Gravelly Sands, Little or No Fines.
		Sands With Fines	SM		Silty Sands, Sand-Silt Mixtures.
			SC		Clayey Sands, Sand-Clay Mixtures.
FINE-GRAINED SOILS 50% or More Passe The No.200 Sieve Based on The Material Passing The 3-Inch (75mm) Sieve. Reference: ASTM Standard D2487	**SILTS AND CLAYS** Liquid Limit Less Than 50%		ML		Inorganic Silts, Very Fine Sands, Rock Flour, Silty or Clayey Fine Sands or Clayey Silts With Slight Plasticity.
			CL		Inorganic Clays of Low To Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays.
			OL		Organic Silts and Organic Silty Clays of Low Plasticity
	SILTS AND CLAYS Liquid Limit 50% or Greater		MH		Inorganic Silts, Micaceous or Diatomaceous Fine Sandy or Silty Soils, Elastic Silts.
			CH		Inorganic Clays of High Plasticity, Fat Clays.
			OH		Organic Clays of Medium To High Plasticity, Organic Silts.
HIGHLY ORGANIC SOILS			PT		Peat and Other Highly Organic Soils.

The descriptive terminology of the logs is modified from current ASTM Standards to suit the purposes of this study

ADDITIONAL TESTS

- DS = Direct Shear
- HY = Hydrometer Test
- TC = Triaxial Compression Test
- UC = Unconfined Compression
- CN = Consolidation Test
- (T) = Time Rate
- EX = Expansion Test
- CP = Compaction Test
- PS = Particle Size Distribution
- EI = Expansion Index
- SE = Sand Equivalent Test
- AL = Atterberg Limits
- FC = Chemical Tests
- RV = Resistance Value
- SG = Specific Gravity
- SU = Sulfates
- CH = Chlorides
- MR = Minimum Resistivity
- pH
- (N) = Natural Undisturbed Sample
- (R) = Remolded Sample
- CS = Collapse Test/Swell-Settlement

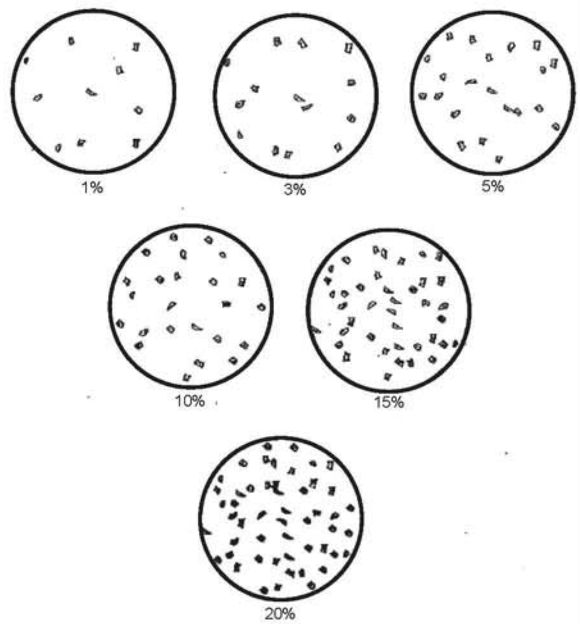
GEOLOGIC NOMENCLATURE

B = Bedding C = Contact J = Joint
F = Fracture Flt = Fault S = Shear
RS = Rupture Surface ○∼ = Seepage
▼ = Groundwater

SAMPLE SYMBOLS

- Undisturbed Sample (California Sample)
- Undisturbed Sample (Shelby Tube)
- Bulk Sample
- Unsuccessful Sampling Attempt
- SPT Sample

5 10 15 Blows per 6-Inches Penetration
10: 10 Blows for 12-Inches Penetration
6/4": 6 Blows for 4-Inches Penetration
P: Push
(13): Uncorrected Blow Counts ("N" Values) for 12-Inches Penetration- Standard Penetration Test (SPT)



GMU	**LEGEND TO LOGS** ASTM Designation: D 2487 (Based on Unified Soil Classification System)	Plate **A-1**

SOIL DENSITY/CONSISTENCY

FINE GRAINED

Consistency	Field Test	SPT (#blows/foot)	Mod (#blows/foot)
Very Soft	Easily penetrated by thumb, exudes between fingers	<2	<3
Soft	Easily penetrated one inch by thumb, molded by fingers	2-4	3-6
Firm	Penetrated over 1/2 inch by thumb with moderate effort	4-8	6-12
Stiff	Penetrated about 1/2 inch by thumb with great effort	8-15	12-25
Very Stiff	Readily indented by thumbnail	15-30	25-50
Hard	Indented with difficulty by thumbnail	>30	>50

COARSE GRAINED

Density	Field Test	SPT (#blows/foot)	Mod (#blows/foot)
Very Loose	Easily penetrated with 0.5" rod pushed by hand	<4	<5
Loose	Easily penetrated with 0.5" rod pushed by hand	4-10	5-12
Medium Dense	Easily penetrated 1' with 0.5" rod driven by 5lb hammer	10-30	12-35
Dense	Dificult to penetrat 1' with 0.5" rod driven by 5lb hammer	31-50	35-60
Very Dense	Penetrated few inches with 0.5" rod driven by 5lb hammer	>50	>60

BEDROCK HARDNESS

Density	Field Test	SPT (#blows/foot)
Soft	Can be crushed by hand, soil like and structureless	1-30
Moderately Hard	Can be grooved with fingernails, crumbles with hammer	30-50
Hard	Can't break by hand, can be grooved with knife	50-100
Very Hard	Scratches with knife, chips with hammer blows	>100

MODIFIERS

Trace	1%
Few	1-5%
Some	5-12%
Numerous	12-20%
Abundant	>20%

GRAIN SIZE

Description		Sieve Size	Grain Size	Approximate Size
Boulders		>12"	>12"	Larger than a basketball
Cobbles		3-12"	3-12"	Fist-sized to basketball-sized
Gravel	Coarse	3/4-3"	3/4-3"	Thumb-sized to fist-sized
	Fine	#4-3/4"	0.19-0.75"	Pea-sized to thumb-sized
Sand	Coarse	#10-#4	0.079-0.19"	Rock-salt-sized to pea-sized
	Medium	#40-#10	0.017-0.079"	Sugar-sized to rock salt-sized
	Fine	#200-#40	0.0029-0.017"	Flour-sized to sugar-sized
Fines		passing #200	<0.0029"	Flour-sized and smaller

MOISTURE CONTENT

Dry- Very little or no moisture
Damp- Some moisture but less than optimum
Moist- Near optimum
Very Moist- Above optimum
Wet/Saturated- Contains free moisture

GMU

LEGEND TO LOGS
ASTM Designation: D 2487
(Based on Unified Soil Classification System)

Plate
A-2

Project: OC Parks Crawford Park **Project Location: North Tustin** **Project Number: 20-188-00**	# Log of Drill Hole DH-1 Sheet 1 of 1

Date(s) Drilled	**4/28/2020**	Logged By	**RVC**	Checked By	**NS**
Drilling Method	**Hollow Stem Auger**	Drilling Contractor	**2R Drilling**	Total Depth of Drill Hole	**11.5 feet**
Drill Rig Type	**CME 75**	Diameter(s) of Hole, inches		Approx. Surface Elevation, ft MSL	**363.0**
Groundwater Depth [Elevation], feet	**N/A []**	Sampling Method(s)	**California Modified Sampler with 6-in sleeve/SPT**	Drill Hole Backfill	**Native**
Remarks				Driving Method and Drop	**140 lb hammer, 30" drop**

ELEVATION, feet	DEPTH, feet	GRAPHIC LOG	GEOLOGICAL CLASSIFICATION AND DESCRIPTION	ORIENTATION DATA	ENGINEERING CLASSIFICATION AND DESCRIPTION	SAMPLE DATA: SAMPLE	SAMPLE DATA: NUMBER OF BLOWS / 6"	SAMPLE DATA: DRIVING WEIGHT, lbs	TEST DATA: MOISTURE CONTENT, %	TEST DATA: DRY UNIT WEIGHT, pcf	TEST DATA: ADDITIONAL TESTS
			ALLUVIUM (Qal)		CLAYEY SAND (SC); yellowish brown and dark grayish brown, moist soft, fine grained sand				13		PS, HY, AL
360											
					SILTY SAND (SM); brown, damp, loose, fine grained sand						
	5						3		26	96	
					SANDY CLAY (CL); dark grayish brown, firm, damp to moist, fine grained sand		6 6				
355											
	10						3				
					POORLY GRADED SAND (SP); grayish brown, damp, very loose, fine to medium grained sand		2 3				
					Total Depth = 11.5 ft No groundwater						

DH_REV3 20-188-00.GPJ GMULAB.GPJ 6/22/20

GMU

Drill Hole DH-1

Project: OC Parks Crawford Park Project Location: North Tustin Project Number: 20-188-00	**Log of Drill Hole DH-2** Sheet 1 of 2

Date(s) Drilled	**4/28/2020**	Logged By	**RVC**	Checked By	**NS**
Drilling Method	**Hollow Stem Auger**	Drilling Contractor	**2R Drilling**	Total Depth of Drill Hole	**21.5 feet**
Drill Rig Type	**CME 75**	Diameter(s) of Hole, inches		Approx. Surface Elevation, ft MSL	**374.0**
Groundwater Depth [Elevation], feet	**N/A []**	Sampling Method(s)	**California Modified Sampler with 6-in sleeve/SPT**	Drill Hole Backfill	**Native**
Remarks				Driving Method and Drop	**140 lb hammer, 30" drop**

ELEVATION, feet	DEPTH, feet	GRAPHIC LOG	GEOLOGICAL CLASSIFICATION AND DESCRIPTION	ORIENTATION DATA	ENGINEERING CLASSIFICATION AND DESCRIPTION	SAMPLE DATA: SAMPLE	SAMPLE DATA: NUMBER OF BLOWS / 6"	SAMPLE DATA: DRIVING WEIGHT, lbs	TEST DATA: MOISTURE CONTENT, %	TEST DATA: DRY UNIT WEIGHT, pcf	TEST DATA: ADDITIONAL TESTS
	0		**ARTIFICIAL FILL (Qaf)**		SANDY CLAY (CL); yellowish and dark brown, damp, medium dense, fine grained sand	Bulk			15		CP
370											
	5		**ALLUVIUM (Qal)**		CLAYEY SAND (SC); yellowish and dark brown, damp, medium dense, fine grained sand	Cal. Mod.	9 9 9		23	101	
365											
	10					SPT	7 8 7				
360											
	15				Becomes very dense	Cal. Mod.	13 29 44		12	121	
355											

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GMU

Project: OC Parks Crawford Park Project Location: North Tustin Project Number: 20-188-00	**Log of Drill Hole DH-2** Sheet 2 of 2

ELEVATION, feet	DEPTH, feet	GRAPHIC LOG	GEOLOGICAL CLASSIFICATION AND DESCRIPTION	ORIENTATION DATA	ENGINEERING CLASSIFICATION AND DESCRIPTION	SAMPLE DATA: SAMPLE	SAMPLE DATA: NUMBER OF BLOWS / 6"	SAMPLE DATA: DRIVING WEIGHT, lbs	TEST DATA: MOISTURE CONTENT, %	TEST DATA: DRY UNIT WEIGHT, pcf	TEST DATA: ADDITIONAL TESTS
			ALLUVIUM (Qal)		SILTY SAND (SM); brown, dry to damp, medium dense, fine grained sand		5 9 9				
					Total Depth = 21.5 ft Nogroundwater						

Project: OC Parks Crawford Park Project Location: North Tustin Project Number: 20-188-00	**Log of Drill Hole DH-3** Sheet 1 of 2

Date(s) Drilled	**4/28/2020**	Logged By	**RVC**	Checked By	**NS**
Drilling Method	**Hollow Stem Auger**	Drilling Contractor	**2R Drilling**	Total Depth of Drill Hole	**21.5 feet**
Drill Rig Type	**CME 75**	Diameter(s) of Hole, inches		Approx. Surface Elevation, ft MSL	**366.0**
Groundwater Depth [Elevation], feet	**N/A []**	Sampling Method(s)	**California Modified Sampler with 6-in sleeve/SPT**	Drill Hole Backfill	**Native**
Remarks				Driving Method and Drop	**140 lb hammer, 30" drop**

ELEVATION, feet	DEPTH, feet	GRAPHIC LOG	GEOLOGICAL CLASSIFICATION AND DESCRIPTION	ORIENTATION DATA	ENGINEERING CLASSIFICATION AND DESCRIPTION	SAMPLE DATA: SAMPLE	SAMPLE DATA: NUMBER OF BLOWS / 6"	SAMPLE DATA: DRIVING WEIGHT, lbs	TEST DATA: MOISTURE CONTENT, %	TEST DATA: DRY UNIT WEIGHT, pcf	TEST DATA: ADDITIONAL TESTS
	0		**ALLUVIUM (Qal)**		SANDY CLAY (CL); brown, damp, dense, fine grained sand				14		EI
365											
	5				CLAYEY SAND (SC); brown, damp, dense, fine grained sand, white veins		16 16 22		10	118	DS
360											
	10				Becomes moist		6 7 10				
355											
	15						4 5 8		15	109	
350											

Drill Hole DH-3

GMU

Project: OC Parks Crawford Park
Project Location: North Tustin
Project Number: 20-188-00

Log of Drill Hole DH-3

ELEVATION, feet	DEPTH, feet	GRAPHIC LOG	GEOLOGICAL CLASSIFICATION AND DESCRIPTION	ORIENTATION DATA	ENGINEERING CLASSIFICATION AND DESCRIPTION	SAMPLE DATA: SAMPLE	SAMPLE DATA: NUMBER OF BLOWS / 6"	SAMPLE DATA: DRIVING WEIGHT, lbs	TEST DATA: MOISTURE CONTENT, %	TEST DATA: DRY UNIT WEIGHT, pcf	TEST DATA: ADDITIONAL TESTS
345			**ALLUVIUM (Qal)**		CLAYEY SAND (SC); brown, damp, medium dense, fine to medium grained sand		10 13 16				
					Total Depth = 21.5 ft Nogroundwater						

Project: OC Parks Crawford Park **Project Location:** North Tustin **Project Number:** 20-188-00	# Log of Drill Hole DH-4 Sheet 1 of 1

Date(s) Drilled	**4/28/2020**	Logged By	**RVC**	Checked By	**NS**
Drilling Method	**Hollow Stem Auger**	Drilling Contractor	**2R Drilling**	Total Depth of Drill Hole	**11.5 feet**
Drill Rig Type	**CME 75**	Diameter(s) of Hole, inches		Approx. Surface Elevation, ft MSL	**360.0**
Groundwater Depth [Elevation], feet	**N/A []**	Sampling Method(s)	**California Modified Sampler with 6-in sleeve/SPT**	Drill Hole Backfill	**Native**
Remarks				Driving Method and Drop	**140 lb hammer, 30" drop**

ELEVATION, feet	DEPTH, feet	GRAPHIC LOG	GEOLOGICAL CLASSIFICATION AND DESCRIPTION	ORIENTATION DATA	ENGINEERING CLASSIFICATION AND DESCRIPTION	SAMPLE DATA: SAMPLE	SAMPLE DATA: NUMBER OF BLOWS / 6"	SAMPLE DATA: DRIVING WEIGHT, lbs	TEST DATA: MOISTURE CONTENT, %	TEST DATA: DRY UNIT WEIGHT, pcf	TEST DATA: ADDITIONAL TESTS
			ALLUVIUM (Qal)		CLAYEYSAND (SC); brown, dry to damp, medium dense, numerous gravel				4		CP
355	5				Becomes reddish and grayish brown, moist, medium dense, fine grained sand		5 6 13		13	117	
					SILTY CLAY (CL); dark grayish brown, loose, fine grained sand						
350	10				CLAYEY SAND (SC); dark grayish brown, dense, fine grained sand		4 6 8				
					Total depth = 11.5 No groundwater						

DH_REV3 20-188-00.GPJ GMULAB.GPJ 6/22/20

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Drill Hole DH-4

Project: OC Parks Crawford Park Project Location: North Tustin Project Number: 20-188-00	**Log of Drill Hole DH-5** Sheet 1 of 1

Date(s) Drilled	**4/28/2020**	Logged By	**RVC**	Checked By	**NS**
Drilling Method	**Hollow Stem Auger**	Drilling Contractor	**2R Drilling**	Total Depth of Drill Hole	**11.5 feet**
Drill Rig Type	**CME 75**	Diameter(s) of Hole, inches		Approx. Surface Elevation, ft MSL	**357.0**
Groundwater Depth [Elevation], feet	**N/A []**	Sampling Method(s)	**California Modified Sampler with 6-in sleeve/SPT**	Drill Hole Backfill	**Native**
Remarks				Driving Method and Drop	**140 lb hammer, 30" drop**

ELEVATION, feet	DEPTH, feet	GRAPHIC LOG	GEOLOGICAL CLASSIFICATION AND DESCRIPTION	ORIENTATION DATA	ENGINEERING CLASSIFICATION AND DESCRIPTION	SAMPLE DATA: SAMPLE	SAMPLE DATA: NUMBER OF BLOWS / 6"	SAMPLE DATA: DRIVING WEIGHT, lbs	TEST DATA: MOISTURE CONTENT, %	TEST DATA: DRY UNIT WEIGHT, pcf	TEST DATA: ADDITIONAL TESTS
			ALLUVIUM (Qal)		CLAYEY SAND (SC); dark brown, damp to moist, dense, fine grained sand, some gravel up to 1"	Bulk			13		PS, HY, AL, FC
355											
	5					California	7 8 13		22	97	
					CLAYEY SILT (ML); grayish brown, moist, stiff, trace finr grained sand, olive and orange pockets						
350											
	10				CLAYEY SAND (SC); dark brown, moist, dense, fine grained sand	SPT	7 7 11				
					Total Depth = 11.5 ft No groundwater						

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Drill Hole DH-5

Project: OC Parks Crawford Park	**Log of Drill Hole DH-6**
Project Location: North Tustin	Sheet 1 of 1
Project Number: 20-188-00	

Date(s) Drilled	**4/28/2020**	Logged By	**RVC**	Checked By	**NS**
Drilling Method	**Hollow Stem Auger**	Drilling Contractor	**2R Drilling**	Total Depth of Drill Hole	**3.0 feet**
Drill Rig Type	**CME 75**	Diameter(s) of Hole, inches		Approx. Surface Elevation, ft MSL	**352.0**
Groundwater Depth [Elevation], feet	**N/A []**	Sampling Method(s)	**California Modified Sampler with 6-in sleeve/SPT**	Drill Hole Backfill	**Native**
Remarks				Driving Method and Drop	**140 lb hammer, 30" drop**

ELEVATION, feet	DEPTH, feet	GRAPHIC LOG	GEOLOGICAL CLASSIFICATION AND DESCRIPTION	ORIENTATION DATA	ENGINEERING CLASSIFICATION AND DESCRIPTION	SAMPLE DATA: SAMPLE	SAMPLE DATA: NUMBER OF BLOWS / 6"	SAMPLE DATA: DRIVING WEIGHT, lbs	TEST DATA: MOISTURE CONTENT, %	TEST DATA: DRY UNIT WEIGHT, pcf	TEST DATA: ADDITIONAL TESTS
350			**ALLUVIUM (Qal)**		CLAYEY SAND (SC); dark brown, damp, soft, fine grained sand	X			12		
					Total Depth = 3 ft No groundwater						

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Drill Hole DH-6

Project: OC Parks Crawford Park Project Location: North Tustin Project Number: 20-188-00	**Log of Drill Hole DH-7** Sheet 1 of 1

Date(s) Drilled	4/28/2020	Logged By	RVC	Checked By	NS
Drilling Method	Hollow Stem Auger	Drilling Contractor	2R Drilling	Total Depth of Drill Hole	5.0 feet
Drill Rig Type	CME 75	Diameter(s) of Hole, inches		Approx. Surface Elevation, ft MSL	352.0
Groundwater Depth [Elevation], feet	N/A []	Sampling Method(s)	California Modified Sampler with 6-in sleeve/SPT	Drill Hole Backfill	Native
Remarks				Driving Method and Drop	140 lb hammer, 30" drop

ELEVATION, feet	DEPTH, feet	GRAPHIC LOG	GEOLOGICAL CLASSIFICATION AND DESCRIPTION	ORIENTATION DATA	ENGINEERING CLASSIFICATION AND DESCRIPTION	SAMPLE DATA: SAMPLE	SAMPLE DATA: NUMBER OF BLOWS / 6"	SAMPLE DATA: DRIVING WEIGHT, lbs	TEST DATA: MOISTURE CONTENT, %	TEST DATA: DRY UNIT WEIGHT, pcf	TEST DATA: ADDITIONAL TESTS
350			**ALLUVIUM (Qal)**		CLAYEY SAND (SC); dark brown, damp, soft, fine grained	X			13		PS, HY
	5				Total Depth = 5 ft No groundwater						

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Drill Hole DH-7

Project: OC Parks Crawford Park	**Log of Drill Hole DH-8**
Project Location: North Tustin	Sheet 1 of 1
Project Number: 20-188-00	

Date(s) Drilled	**4/28/2020**	Logged By	**RVC**	Checked By	**NS**
Drilling Method	**Hollow Stem Auger**	Drilling Contractor	**2R Drilling**	Total Depth of Drill Hole	**11.5 feet**
Drill Rig Type	**CME 75**	Diameter(s) of Hole, inches		Approx. Surface Elevation, ft MSL	**350.0**
Groundwater Depth [Elevation], feet	**N/A []**	Sampling Method(s)	**California Modified Sampler with 6-in sleeve/SPT**	Drill Hole Backfill	**Native**
Remarks				Driving Method and Drop	**140 lb hammer, 30" drop**

ELEVATION, feet	DEPTH, feet	GRAPHIC LOG	GEOLOGICAL CLASSIFICATION AND DESCRIPTION	ORIENTATION DATA	ENGINEERING CLASSIFICATION AND DESCRIPTION	SAMPLE DATA: SAMPLE	SAMPLE DATA: NUMBER OF BLOWS / 6"	SAMPLE DATA: DRIVING WEIGHT, lbs	TEST DATA: MOISTURE CONTENT, %	TEST DATA: DRY UNIT WEIGHT, pcf	TEST DATA: ADDITIONAL TESTS
			ALLUVIUM (Qal)		CLAYEY SAND (SC); brown, soft, moist, fine grained sand				16		EI
345	5						5 6 7		13	102	
340	10						3 3 3				
					Total depth = 11.5 ft No groundwater						

DH_REV3 20-188-00.GPJ GMULAB.GPJ 6/22/20

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Drill Hole DH-8

Project: OC Parks Crawford Park Project Location: North Tustin Project Number: 20-188-00	**Log of Drill Hole DH-9** Sheet 1 of 2

Date(s) Drilled	4/28/2020	Logged By	RVC	Checked By	NS
Drilling Method	Hollow Stem Auger	Drilling Contractor	2R Drilling	Total Depth of Drill Hole	26.5 feet
Drill Rig Type	CME 75	Diameter(s) of Hole, inches		Approx. Surface Elevation, ft MSL	346.0
Groundwater Depth [Elevation], feet	N/A []	Sampling Method(s)	California Modified Sampler with 6-in sleeve/SPT	Drill Hole Backfill	Native
Remarks				Driving Method and Drop	140 lb hammer, 30" drop

ELEVATION, feet	DEPTH, feet	GRAPHIC LOG	GEOLOGICAL CLASSIFICATION AND DESCRIPTION	ORIENTATION DATA	ENGINEERING CLASSIFICATION AND DESCRIPTION	SAMPLE	NUMBER OF BLOWS / 6"	DRIVING WEIGHT, lbs	MOISTURE CONTENT, %	DRY UNIT WEIGHT, pcf	ADDITIONAL TESTS
			ALLUVIUM (Qal)		CLAYEY SAND (SM); brown, dry, dense, fine grained sand				10		RV, FC
345											
					Becomes damp, loose						
	5								11	98	DS
340											
	10										
335											
	15								11	109	
330											

DH_REV3 20-188-00.GPJ GMULAB.GPJ 6/22/20

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Drill Hole DH-9

Project: OC Parks Crawford Park
Project Location: North Tustin
Project Number: 20-188-00

Log of Drill Hole DH-9

ELEVATION, feet	DEPTH, feet	GRAPHIC LOG	GEOLOGICAL CLASSIFICATION AND DESCRIPTION	ORIENTATION DATA	ENGINEERING CLASSIFICATION AND DESCRIPTION	SAMPLE DATA: SAMPLE	SAMPLE DATA: NUMBER OF BLOWS / 6"	SAMPLE DATA: DRIVING WEIGHT, lbs	TEST DATA: MOISTURE CONTENT, %	TEST DATA: DRY UNIT WEIGHT, pcf	TEST DATA: ADDITIONAL TESTS
325			**ALLUVIUM (Qal)**		CLAYEY SAND (SC); brown, damp, loose to medium dense, fine grained sand						
320	25				SILTY SAND (SM); brown, damp, dense, fine grained sand				6	115	
					Total depth = 26.5 ft No groundwater						

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APPENDIX B

Geotechnical Laboratory Procedures and Test Results

APPENDIX B

GMU GEOTECHNICAL LABORATORY PROCEDURES AND TEST RESULTS

MOISTURE AND DENSITY

Field moisture content and in-place density were determined for each 6-inch sample sleeve of undisturbed soil material obtained from the drill holes. The field moisture content was determined in general accordance with ASTM Test Method D 2216 by obtaining one-half the moisture sample from each end of the 6-inch sleeve. The in-place dry density of the sample was determined by using the wet weight of the entire sample.

At the same time the field moisture content and in-place density were determined, the soil material at each end of the sleeve was classified according to the Unified Soil Classification System. The results of the field moisture content and in-place density determinations are presented on the right-hand column of the Log of Drill Hole and are summarized on Table B-1. The results of the visual classifications were used for general reference.

PARTICLE SIZE DISTRIBUTION

As part of the engineering classification of the materials underlying the site, samples were tested to determine the distribution of particle sizes. The distribution was determined in general accordance with ASTM Test Method D 422 using U.S. Standard Sieve Openings 3", 1.5", 3/4, 3/8, and U.S. Standard Sieve Nos. 4, 10, 20, 40, 60, 100, and 200. In addition, on some samples a standard hydrometer test was performed to determine the distribution of particle sizes passing the No. 200 sieve (i.e., silt and clay-size particles). The results of the tests are contained in Appendix B. Key distribution categories (% gravel; % sand, etc.) are contained on Table B-1.

ATTERBERG LIMITS

As part of the engineering classification of the soil material, samples of the on-site soil material were tested to determine relative plasticity. This relative plasticity is based on the Atterberg limits determined in general accordance with ASTM Test Method D 4318. The results of these tests are contained in this Appendix B and also Table B-1.

EXPANSION TESTS

To provide a standard definition of one-dimensional expansion, a test was performed on typical on-site materials in general accordance with ASTM Test Method D 4829. The result from this test procedure is reported as an "expansion index". The results of this test are contained in Appendix B and also Table B-1.

CHEMICAL TESTS

The corrosion potential of typical on-site materials under long-term contact with both metal and concrete was determined by chemical and electrical resistance tests. The soluble sulfate test for potential concrete corrosion was performed in general accordance with California Test Method 417, the minimum resistivity test for potential metal corrosion was performed in general accordance with California Test Method 643, and the concentration of soluble chlorides was determined in general accordance with California Test Method 422. The results of these tests are contained in Appendix B and also Table B-1.

COMPACTION TESTS

Bulk sample representatives of the on-site materials were tested to determine the maximum dry density and optimum moisture content of the soil. These compactive characteristics were determined in general accordance with ASTM Test Method D 1557. The results of this test are contained in Appendix B and also Table B-1.

DIRECT SHEAR STRENGTH TESTS

Direct shear tests were performed on typical on-site materials. The general philosophy and procedure of the tests were in accord with ASTM Test Method D 3080 - "Direct Shear Tests for Soils Under Consolidated Drained Conditions".

The tests are single shear tests and are performed using a sample diameter of 2.416 inches and a height of 1.00 inch. The normal load is applied by a vertical dead load system. A constant rate of strain is applied to the upper one-half of the sample until failure occurs. Shear stress is monitored by a strain gauge-type precision load cell and deflection is measured with a digital dial indicator. This data is transferred electronically to data acquisition software which plots shear strength vs. deflection. The shear strength plots are then interpreted to determine either peak or ultimate shear strengths. Residual strengths were obtained through multiple shear box reversals. A strain rate compatible with the grain size distribution of the soils was utilized. The interpreted results of these tests are shown in Appendix B.

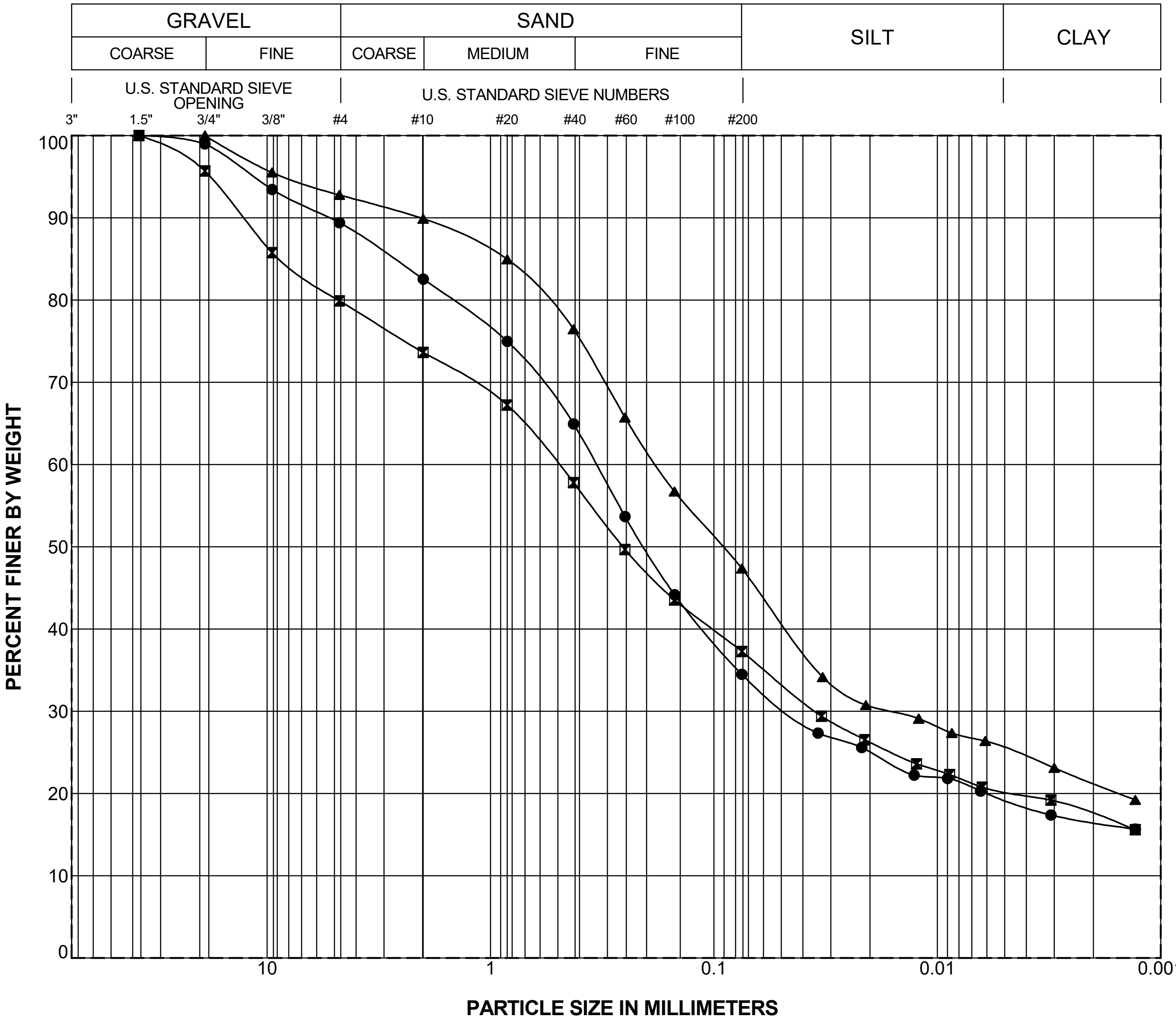
R-VALUE TESTS

Bulk samples representative of the underlying on-site materials were tested to measure the response of a compacted sample to a vertically applied pressure under specific conditions. The R-value of a material is determined when the material is in a state of saturation such that water will be exuded from the compacted test specimen when a 16.8 kN load (2.07 MPa) is applied. The results from these test procedures are reported in this Appendix B-1.

TABLE B-1
SUMMARY OF SOIL LABORATORY DATA

Sample Information			Geologic Unit	USCS Group Symbol	In Situ Water Content, %	In Situ Dry Unit Weight, pcf	In Situ Satur-ation, %	Sieve/Hydrometer				Atterberg Limits			Compaction		Expansion Index	R-Value	Chemical Test Results			
Boring Number	Depth, feet	Elevation, feet						Gravel, %	Sand, %	<#200, %	<2μ, %	LL	PL	PI	Maximum Dry Unit Weight, pcf	Optimum Water Content, %			pH	Sulfate (ppm)	Chloride (ppm)	Min. Resistivity (ohm/cm)
DH-1	0	363.0	Qal	SC	13.1			11	55	34	17	31	14	17								
DH-1	5	358.0	Qal	CL	26.1	96	96															
DH-2	0	374.0	Qaf	CL	15.4										122.0	11.5						
DH-2	5	369.0	Qal	CL/SC	22.9	101	96															
DH-2	15	359.0	Qal	SC	11.7	121	84															
DH-3	0	366.0	Qal	CL	13.5												65					
DH-3	5	361.0	Qal	CL-SC	9.7	118	64															
DH-3	15	351.0	Qal	SC	15.3	109	79															
DH-4	0	360.0	Qal	SC	4.3										135.5	7.0						
DH-4	5	355.0	Qal	SC	13.3	117	85															
DH-5	0	357.0	Qal	SC	13.1			20	43	37	17	36	14	22					8.3	537	1128	990
DH-5	5	352.0	Qal	ML	22.4	97	84															
DH-6	0	352.0	Qal	SC	12.2																	
DH-7	0	352.0	Qal	SC	13.1			7	45	47	21											
DH-8	0	350.0	Qal	CL-SC	16.1												46					
DH-8	5	345.0	Qal	SC	13.0	102	56															
DH-9	0	346.0	Qal	SC	9.7													26	8.3	10	264	1576
DH-9	5	341.0	Qal	CL-SC	11.4	98	43															
DH-9	15	331.0	Qal	SC	11.5	109	59															
DH-9	25	321.0	Qal	SM	6.1	115	37															

Project: OC Parks Crawford Park
Project No. 20-188-00



Boring Number	Depth (feet)	Geologic Unit	Symbol	LL	PI	Classification
DH-1	0.0	Qal	●	31	17	CLAYEY SAND (SC)
DH-5	0.0	Qal	⊠	36	22	CLAYEY SAND with GRAVEL (SC)
DH-7	0.0	Qal	▲			CLAYEY SAND (SC)

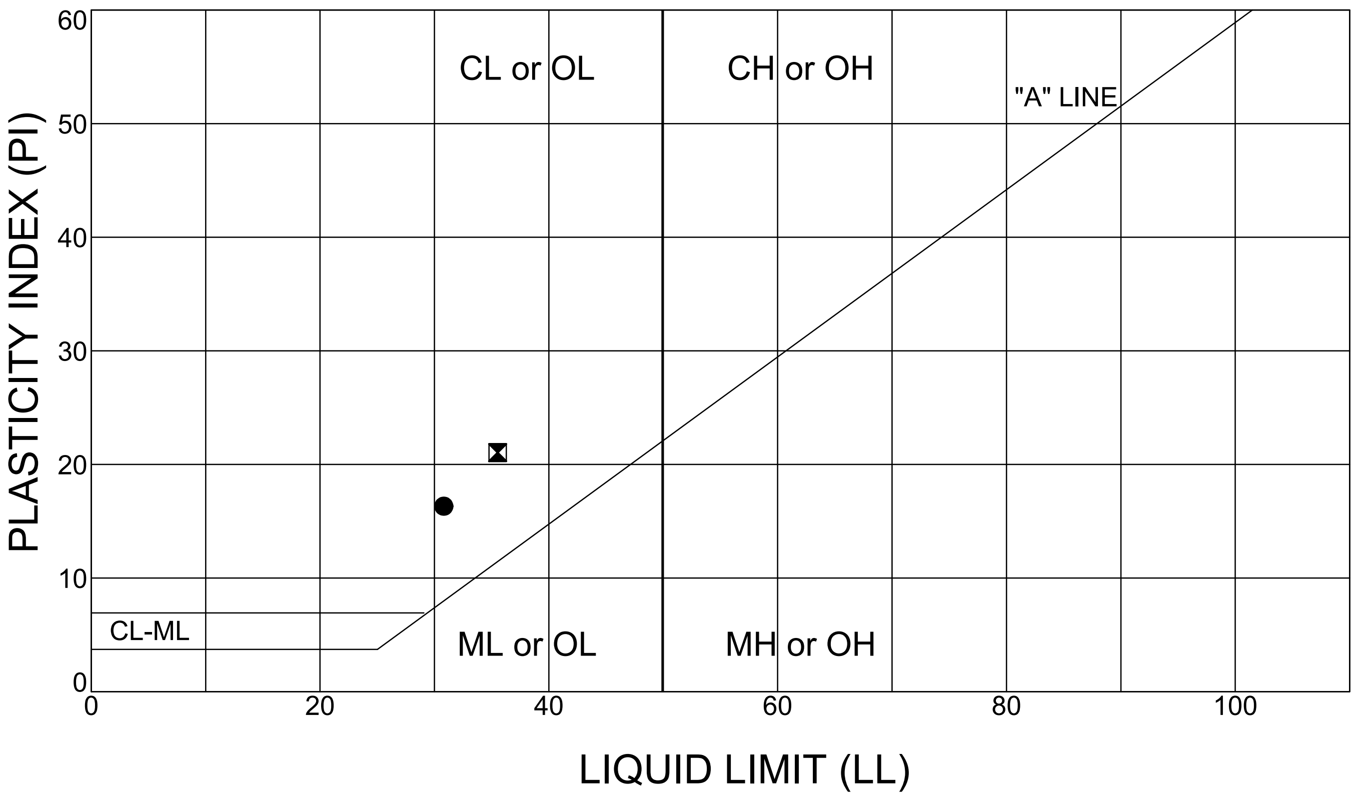
GMU_GRAIN_SIZE 20-188-00.GPJ 6/3/20

PARTICLE SIZE DISTRIBUTION

Project: OC Parks Crawford Park

Project No. 20-188-00

GMU



Boring Number	Depth (feet)	Geologic Unit	Test Symbol	Insitu Water Content (%)	LL	PL	PI	Classification
DH-1	0.0	Qal	●	13	31	14	17	CLAYEY SAND (SC)
DH-5	0.0	Qal	⧗	13	36	14	22	CLAYEY SAND with GRAVEL (SC)

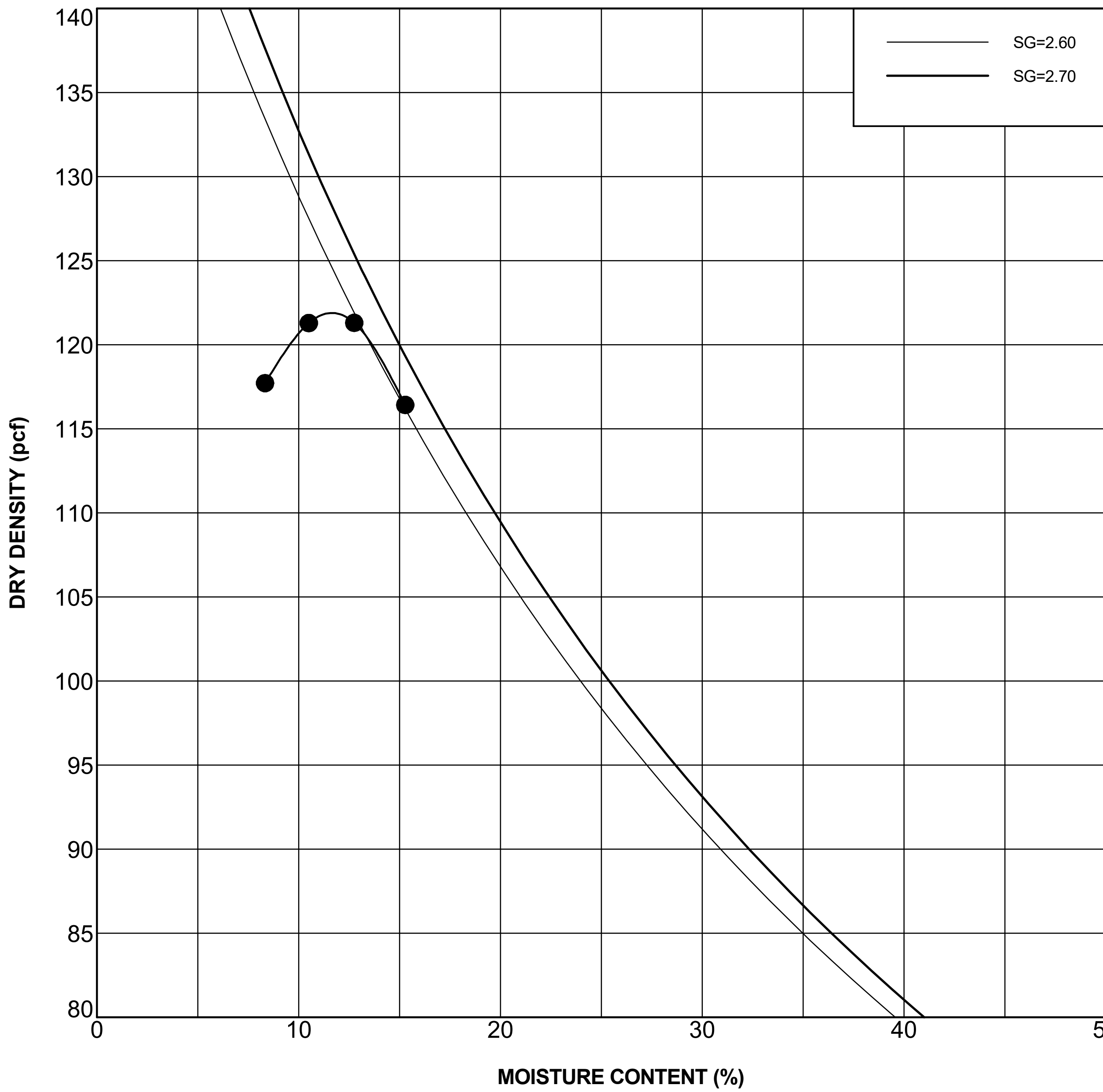
LIMITS 20-188-00.GPJ 6/23/20

ATTERBERG LIMITS

Project: OC Parks Crawford Park

Project No. 20-188-00

GMU



Boring Number	Depth (feet)	Geologic Unit	Symbol	Maximum Dry Density, pcf	Optimum Moisture Content, %	Classification
DH-2	0.0	Qal	●	122	11.5	SANDY CLAY (CL)

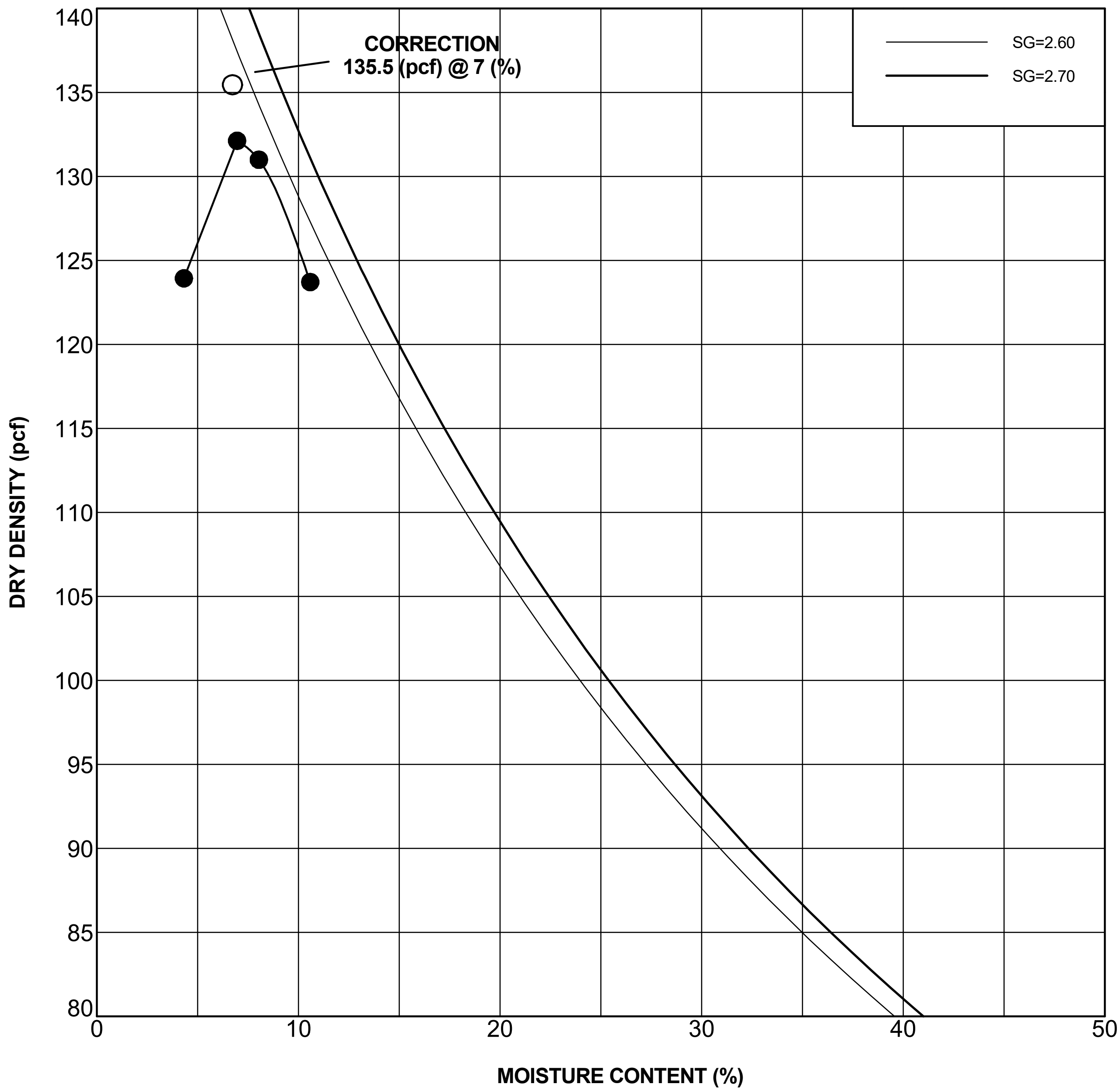
DVTCOMP 20-188-00.GPJ 6/3/20

COMPACTION TEST DATA

Project: OC Parks Crawford Park

Project No. 20-188-00

GMU



Boring Number	Depth (feet)	Geologic Unit	Symbol	Maximum Dry Density, pcf	Optimum Moisture Content, %	Classification
DH-4	0.0	Qal	●	135.5	7	CLAYEY SAND with GRAVEL (SC)

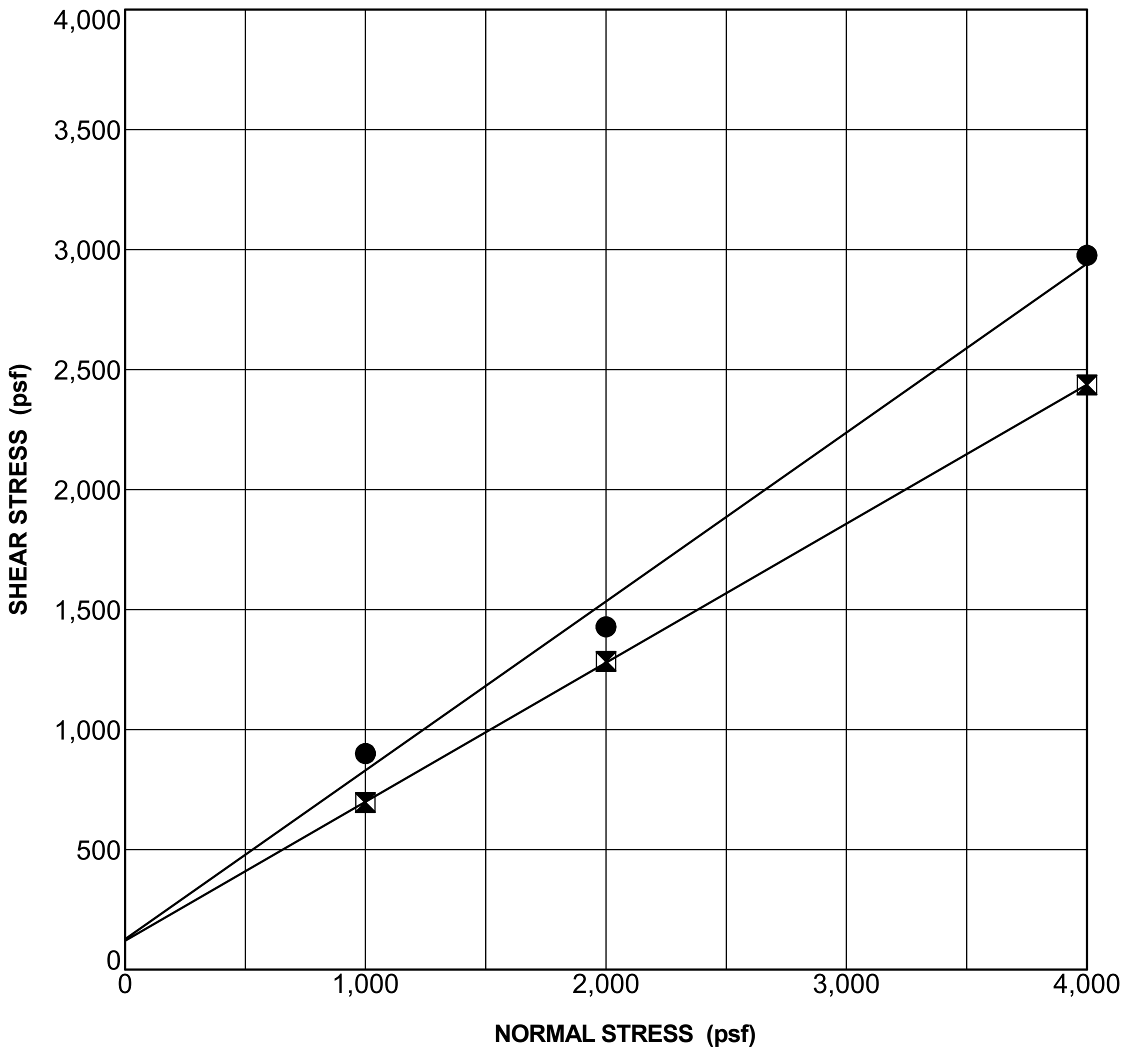
DVTCOMP 20-188-00.GPJ 6/3/20

COMPACTION TEST DATA

Project: OC Parks Crawford Park

Project No. 20-188-00

GMU



SAMPLE AND TEST DESCRIPTION
Sample Location: DH-3 @ 5.0 ft **Geologic Unit:** Qal **Classification:** SANDY CLAY (CL-SC)
Strain Rate (in/min): 0.005 **Sample Preparation:** Undisturbed
Notes: Sample saturated prior and during shearing

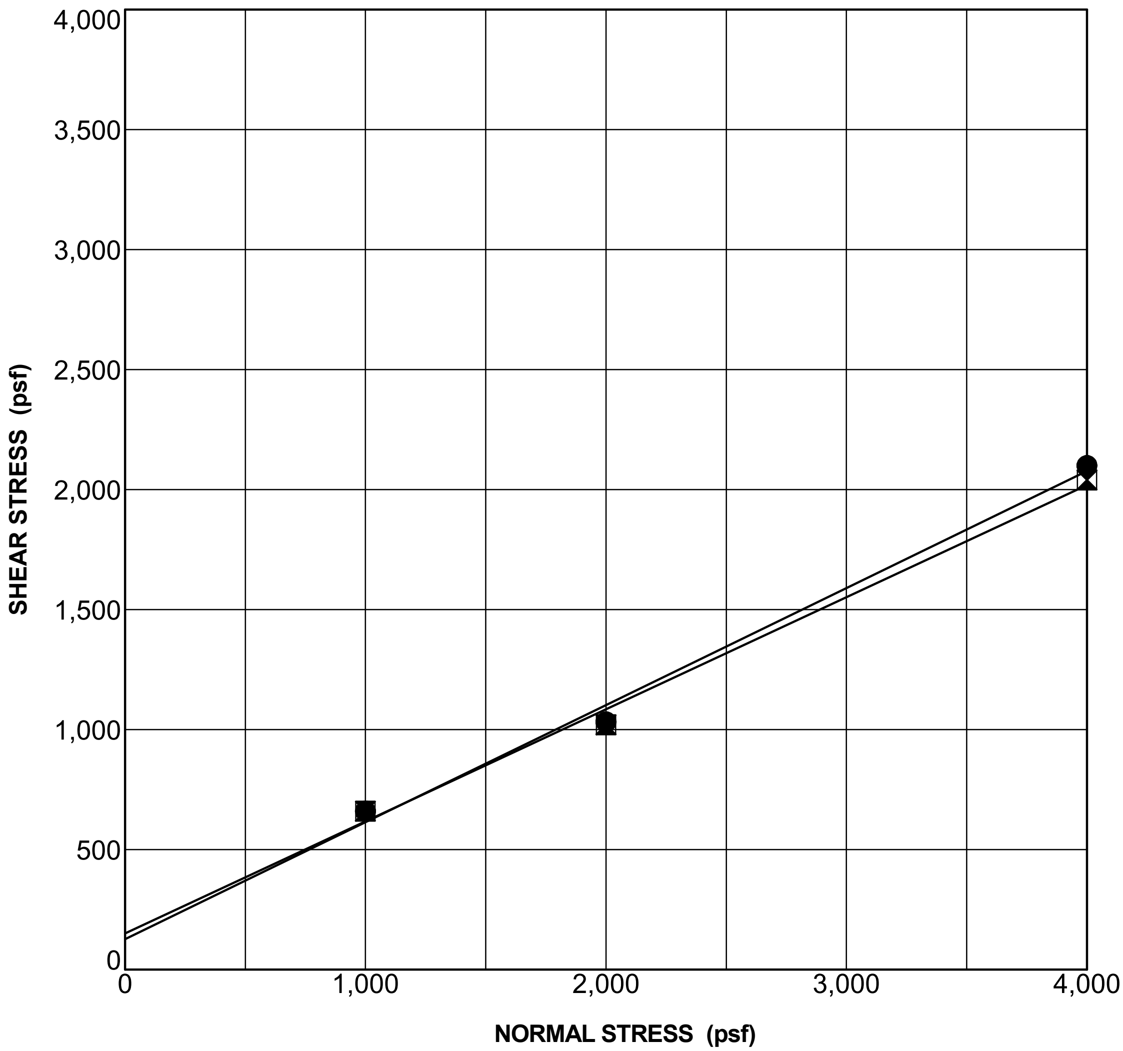
STRENGTH PARAMETERS		
STRENGTH TYPE	COHESION (psf)	FRICTION ANGLE (degrees)
● Peak Strength	126	35.1
⧗ Ultimate Strength	120	30.1

GMU_DIRECT_SHEAR 20-188-00.GPJ GM&U.GDT 6/3/20

SHEAR TEST DATA

Project: OC Parks Crawford Park
Project No. 20-188-00

GMU



SAMPLE AND TEST DESCRIPTION
Sample Location: DH-9 @ 5.0 ft **Geologic Unit:** Qal **Classification:** SANDY CLAY (CL-SC)
Strain Rate (in/min): 0.005 **Sample Preparation:** Undisturbed
Notes: Sample saturated prior and during shearing

STRENGTH PARAMETERS		
STRENGTH TYPE	**COHESION (psf)**	**FRICTION ANGLE (degrees)**
● Peak Strength	126	26.0
⧗ Ultimate Strength	150	25.0

SHEAR TEST DATA

Project: OC Parks Crawford Park
Project No. 20-188-00

APPENDIX C

Infiltration Test Results

Encased Falling Head Infiltration Test

Project Name:	OC Parks Crawford Park	**Date:**	4/29/2020
Project Number:	20-188-00	**Tested By:**	RC
Test Hole Number:	DH-5	**USCS Soil Classification:**	SC
Total Depth :	5.00 feet	**Water Temperature:**	70 °F
Test Hole Diameter:	6.00 inches	radius= 3	inches

	Test No.	Start Time	End Time	ΔT (min)	Total Time (min)	Initial Depth of Water (ft)	Final Depth of Water (ft)	H_0 (in)	H_f (in)	ΔH (in)	Unfactored Infiltration Rate (in/hour)
Trial 1	1	8:18	8:38	20.0	60.0	4.00	4.06	12.00	11.25	0.75	2.25
	2	8:38	8:58	20.0	80.0	4.06	4.09	11.25	10.88	0.38	1.13
	3	8:58	9:18	20.0	100.0	4.09	4.13	10.88	10.50	0.38	1.13
	4	9:18	9:38	20.0	120.0	4.13	4.16	10.50	10.13	0.38	1.13
	5	9:38	9:58	20.0	140.0	4.16	4.18	10.13	9.88	0.25	0.75
	6	9:58	10:18	20.0	160.0	4.18	4.21	9.88	9.50	0.38	1.13
Trial 2	1	10:18	10:38	20.0	180.0	4.00	4.04	12.00	11.50	0.50	1.50
	2	10:38	10:58	20.0	200.0	4.04	4.06	11.50	11.25	0.25	0.75
	3	10:58	11:18	20.0	220.0	4.06	4.10	11.25	10.75	0.50	1.50
	4	11:18	11:38	20.0	240.0	4.10	4.13	10.75	10.50	0.25	0.75
	5	11:38	11:58	20.0	260.0	4.13	4.15	10.50	10.25	0.25	0.75
	6	11:58	12:18	20.0	280.0	4.15	4.17	10.25	10.00	0.25	0.75
Trial 3	1	12:15	12:35	20.0	300.0	4.00	4.02	12.00	11.75	0.25	0.75
	2	12:35	12:55	20.0	320.0	4.02	4.05	11.75	11.38	0.38	1.13
	3	12:55	13:15	20.0	340.0	4.05	4.06	11.38	11.25	0.13	0.37
	4	13:15	13:35	20.0	360.0	4.06	4.09	11.25	10.88	0.38	1.13
	5	13:35	13:55	20.0	380.0	4.09	4.13	10.88	10.50	0.38	1.13
	6	13:55	14:15	20.0	400.0	4.13	4.17	10.50	10.00	0.50	1.50

WATER TEMPERATURE CORRECTION FACTOR:	0.90
SAFETY FACTOR*:	2
UNFACTORED INFILTRATION RATE (IN/HR):	1.35
FACTORED INFILTRATION RATE (IN/HR):	0.67

Factor Category	Factor Description	Assigned Weight (w)	Factor Value (v)	Product (p) = w x v
Suitability Assessment	Soil assessment methods	0.25	2	0.5
	Predominant soil texture	0.25	2	0.5
	Site soil variablity	0.25	2	0.5
	Depth to groundwater	0.25	1	0.25
			Geotechnical Factor of Safety (SA):	1.75

Concern Level	Factor Value (v)
Low	1
Medium	2
High	3

Factor Description	High Concern	Medium Concern	Low Concern
Soil assessment methods	Use of borhole methods to estimate vertical infiltration rate (not recommended, but may be necessary at a planning level). Less than 2 tests per BMP	At least 2 tests per BMP. Use of borehole tests for dry wells or infiltration trenches. Use of infiltrometer or small scale PIT methods for vertical infiltration BMPs.	Extensive infiltration testing such as: PIT testing or infiltrometer testing at 3+ locations per BMP, and/or commitment to construction phase testing and design adaption if necessary.
Predominant soil texture	Silty and clayey soils with significant fines	Finer sandy soils with some loam content	Clean, granular soils (sands)
Site soil variablity	Highly variable soils indicated from site assessment or limited soil borings collected during site assessment.	Soil borings/test pits indicate moderately homogeneous soils.	Multiple soil borings/test pits indicate relatively homogeneous soils.
Depth to groundwater	Groundwater conditions or movement not well understood.	Seasonal high GW at least 10 ft below facility bottom.	Seasonal high GW at least 15 ft below facility bottom.

***Factor of safety should not be less than 2. Additional factor of safety in accordance with Table D-7 of the South Orange County Technical Guidance Document should be applied by the project civil engineer.**

Encased Falling Head Infiltration Test

Project Name:	OC Parks Crawford Park	**Date:**	4/29/2020
Project Number:	20-188-00	**Tested By:**	RC
Test Hole Number:	DH-6	**USCS Soil Classification:**	SC
Total Depth :	3.00 feet	**Water Temperature:**	70 °F
Test Hole Diameter:	6.00 inches	radius= 3 inches	

	Test No.	Start Time	End Time	ΔT (min)	Total Time (min)	Initial Depth of Water (ft)	Final Depth of Water (ft)	H_0 (in)	H_f (in)	ΔH (in)	Unfactored Infiltration Rate (in/hour)
Trial 1	1	8:15	8:35	20.0	60.0	2.00	2.10	12.00	10.75	1.25	3.75
	2	8:35	8:55	20.0	80.0	2.10	2.13	10.75	10.50	0.25	0.75
	3	8:55	9:15	20.0	100.0	2.13	2.15	10.50	10.25	0.25	0.75
	4	9:15	9:35	20.0	120.0	2.15	2.18	10.25	9.88	0.38	1.13
	5	9:35	9:55	20.0	140.0	2.18	2.20	9.88	9.63	0.25	0.75
	6	9:55	10:15	20.0	160.0	2.20	2.21	9.63	9.50	0.13	0.38
Trial 2	1	10:15	10:35	20.0	180.0	2.00	2.03	12.00	11.63	0.38	1.13
	2	10:35	10:55	20.0	200.0	2.03	2.05	11.63	11.38	0.25	0.75
	3	10:55	11:15	20.0	220.0	2.05	2.07	11.38	11.13	0.25	0.75
	4	11:15	11:35	20.0	240.0	2.07	2.08	11.13	11.00	0.13	0.38
	5	11:35	11:55	20.0	260.0	2.08	2.09	11.00	10.88	0.13	0.38
	6	11:55	12:15	20.0	280.0	2.09	2.13	10.88	10.50	0.38	1.13
Trial 3	1	12:15	12:35	20.0	300.0	1.95	1.97	12.63	12.38	0.25	0.75
	2	12:35	12:55	20.0	320.0	1.97	1.99	12.38	12.13	0.25	0.75
	3	12:55	13:15	20.0	340.0	1.99	2.00	12.13	12.00	0.13	0.37
	4	13:15	13:35	20.0	360.0	2.00	2.02	12.00	11.75	0.25	0.75
	5	13:35	13:55	20.0	380.0	2.02	2.03	11.75	11.63	0.13	0.38
	6	13:55	14:15	20.0	400.0	2.03	2.05	11.63	11.38	0.25	0.75

WATER TEMPERATURE CORRECTION FACTOR:	0.90
SAFETY FACTOR*:	2
UNFACTORED INFILTRATION RATE (IN/HR):	0.67
FACTORED INFILTRATION RATE (IN/HR):	0.34

Factor Category	Factor Description	Assigned Weight (w)	Factor Value (v)	Product (p) = w x v
Suitability Assessment	Soil assessment methods	0.25	2	0.5
	Predominant soil texture	0.25	2	0.5
	Site soil variablity	0.25	2	0.5
	Depth to groundwater	0.25	1	0.25
			Geotechnical Factor of Safety (S_A):	1.75

Concern Level	Factor Value (v)
Low	1
Medium	2
High	3

Factor Description	High Concern	Medium Concern	Low Concern
Soil assessment methods	Use of borhole methods to estimate vertical infiltration rate (not recommended, but may be necessary at a planning level). Less than 2 tests per BMP	At least 2 tests per BMP. Use of borehole tests for dry wells or infiltration trenches. Use of infiltrometer or small scale PIT methods for vertical infiltration BMPs.	Extensive infiltration testing such as: PIT testing or infiltrometer testing at 3+ locations per BMP, and/or commitment to construction phase testing and design adaption if necessary.
Predominant soil texture	Silty and clayey soils with significant fines	Finer sandy soils with some loam content	Clean, granular soils (sands)
Site soil variablity	Highly variable soils indicated from site assessment or limited soil borings collected during site assessment.	Soil borings/test pits indicate moderately homogeneous soils.	Multiple soil borings/test pits indicate relatively homogeneous soils.
Depth to groundwater	Groundwater conditions or movement not well understood.	Seasonal high GW at least 10 ft below facility bottom.	Seasonal high GW at least 15 ft below facility bottom.

***Factor of safety should not be less than 2. Additional factor of safety in accordance with Table D-7 of the South Orange County Technical Guidance Document should be applied by the project civil engineer.**