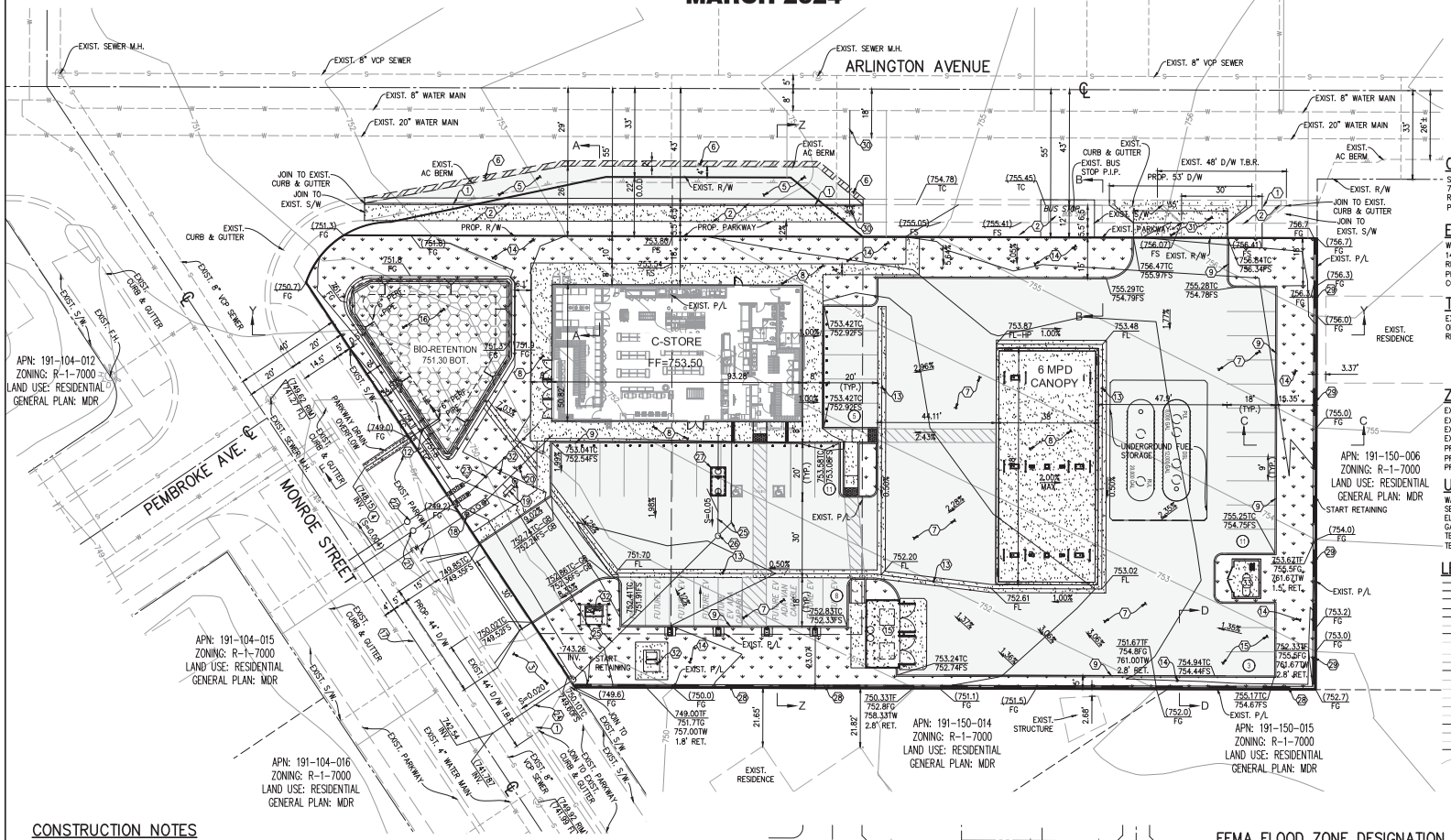
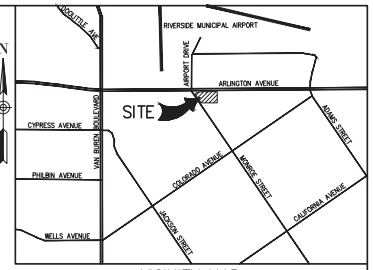
CONCEPTUAL GRADING PLAN
6892 ARLINGTON AVENUE
RIVERSIDE, CALIFORNIA
MARCH 2024





VICINITY MAP
THOMAS GUIDE – PAGE 714 GRID J–2 (2005 EDITION)
SECTION 6, TOWNSHIP 3 SOUTH, RANGE 5 WEST
NOT TO SCALE

OWNER/APPLICANT
STEVEN WALKER COMMUNITIES
7111 INDIANA AVENUE, SUITE 300
RIVERSIDE, CA. 92504
PH: (951) 784-0840

ENGINEER
WOODARD GROUP
1485 SPRUCE ST., STE. "M"
RIVERSIDE, CA 92507
PH: (951) 907-5077
CONTACT: ANDREW C. WOODARD

TOPOGRAPHY SOURCE
EXISTING TOPOGRAPHY IS BASED ON CITY OF RIVERSIDE CADME DATABASE AND RECORD INFORMATION

LEGAL DESCRIPTION
APN: 191-150-003, 191-150-031, 191-150-032

THOSE PORTIONS OF LOT 5 IN BLOCK 4 OF THE LANDS OF THE RIVERSIDE LAND AND IRRIGATING CO., AS SHOWN BY MAP ON FILE IN BOOK 1, PAGE 70 THEREOF, OF MAPS, RECORDS OF SAN BERNARDINO COUNTY CALIFORNIA.

ASSESSOR PARCEL NO

BOOK	PAGE	PARCELS
191	150	031
191	150	032
191	150	033

ACREAGE

APN: 191-150-031	0.70 ACRES
APN: 191-150-032	0.27 ACRES
APN: 191-150-033	0.37 ACRES
GROSS	1.34 ACRES
NET	1.28 ACRES
DISTURBED AREA	1.28 ACRES
OFFER OF DEDICATION	0.06 ACRES

ZONING/LAND USE/GENERAL PLAN
EXISTING ZONING (191-150-032, 191-150-033)..... R-1-7000
EXISTING ZONING (191-150-031) ..... C-R (COMMERCIAL RETAIL)
EXISTING LAND USE: ..... VACANT
EXISTING GENERAL PLAN: ..... O OFFICE
PROPOSED ZONING: ..... CR (COMMERCIAL RETAIL)
PROPOSED LAND USE: ..... SERVICE STATION/RETAIL/RESTAURANT
PROPOSED GENERAL PLAN AMENDMENT: ..... COMMERCIAL RETAIL

UTILITY PROVIDERS
WATER: ..... CITY OF RIVERSIDE
SEWER: ..... CITY OF RIVERSIDE
ELECTRICITY: ..... CITY OF RIVERSIDE
GAS: ..... THE GAS COMPANY
TELEPHONE: ..... VERIZON
TELEVISION: ..... AIR WAVES / CHARTER COMMUNICATIONS

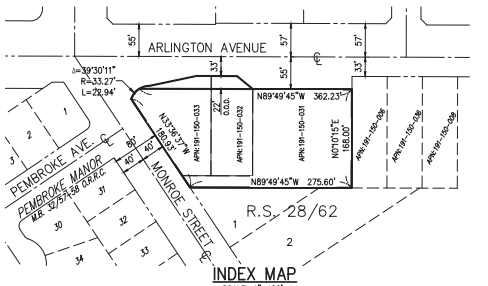
LEGEND
EXISTING PROPERTY LINE
PROPOSED RIGHT OF WAY
EXISTING RIGHT OF WAY
EXISTING CENTERLINE
PROPOSED CURB
EXISTING CURB
PROPOSED SIDEWALK
EXISTING SIDEWALK
EXISTING DIRT ROAD
PROPOSED PARKING STRIPE
EXISTING EASEMENT
EXISTING CONTOUR MAJOR
EXISTING CONTOUR MINOR
EXISTING FENCE
EXISTING BUILDING
EXISTING CONCRETE
PROPOSED UNDERGROUND UTILITY
EXISTING UNDERGROUND UTILITY
EXISTING EDGE OF PAVEMENT
PROPOSED EDGE OF PAVEMENT
EXISTING CONTOUR ELEVATION
EXISTING SPOT ELEVATION

PROPOSED AC PAVEMENT
PROPOSED LANDSCAPE
PROPOSED CONCRETE
PROPOSED BIORETENTION AREA

ABBREVIATIONS

R/W	RIGHT OF WAY
P/L	PROPERTY LINE
EXIST.	EXISTING
PROP.	PROPOSED
S.F.	SQUARE FEET
D/W	DRIVEWAY
S/W	SIDEWALK
M.H.	MANHOLE
FS	FINISH SURFACE
TC	TOP OF CURB
FL	FLOW LINE
FG	FINISH GRADE
TG	TOP OF GRATE
INV.	INVERT
S.D.	STORM DRAIN
EG	EXISTING GROUND
T.B.R.	TO BE REMOVED
P.I.P.	PROTECT IN PLACE
P.P.	POWER POLE
F.H.	FIRE HYDRANT
L/S	LANDSCAPE

CONSTRUCTION NOTES
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INDEX MAP
SCALE: 1"=100'

FEMA FLOOD ZONE DESIGNATION
ZONE X – BASE FLOOD ELEVATIONS DETERMINED.
FLOOD INSURANCE RATE MAP
RIVERSIDE COUNTY, CALIFORNIA AND INCORPORATED AREAS.
PANEL 705 OF 3805
MAP NUMBER 06065C0705G
EFFECTIVE DATE
AUGUST 28, 2008

N
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GRAPHIC SCALE
SCALE: 1" = 20'

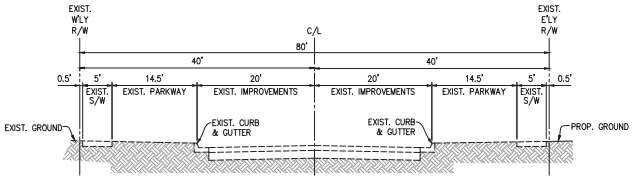
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CONCEPTUAL GRADING PLAN
6892 ARLINGTON AVENUE

FOR: STEVEN WALKER COMMUNITIES
SCALE: 1"=20'
DATE: 03/2024
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CHECKED: AW
PLN CK REF:
F.B.
W.O.
SHEET 1
OF 3 SHEETS
DWG. NO. 1103

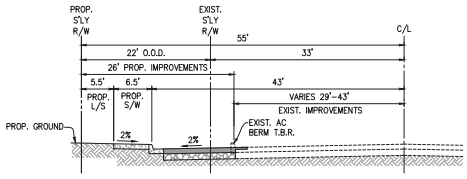
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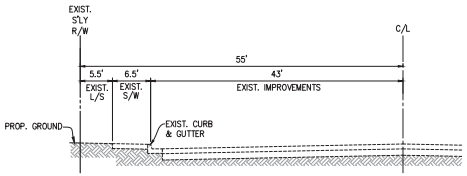
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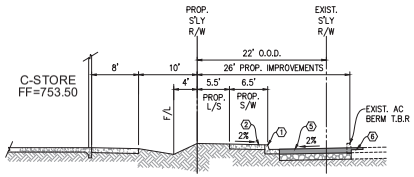
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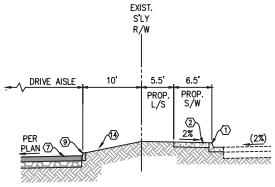
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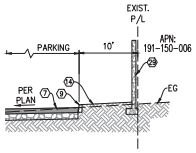
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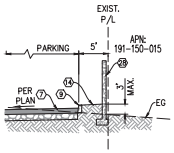
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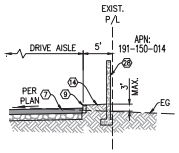
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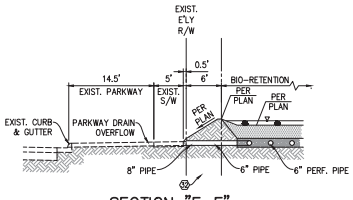


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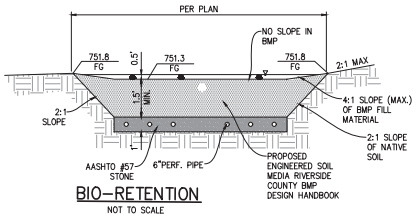
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SECTION "F-F"

SCALE: 1"=10'



BIO-RETENTION

NOT TO SCALE

MARK	REVISIONS	DATE	BY

CONCEPTUAL GRADING PLAN
6892 ARLINGTON AVENUE
SECTIONS

FOR: STEVEN WALKER COMMUNITIES

SCALE:	AS SHOWN
DATE:	03/2024
DESIGNED:	AW
CHECKED:	AW
PLN CK REF:	
F.B.	

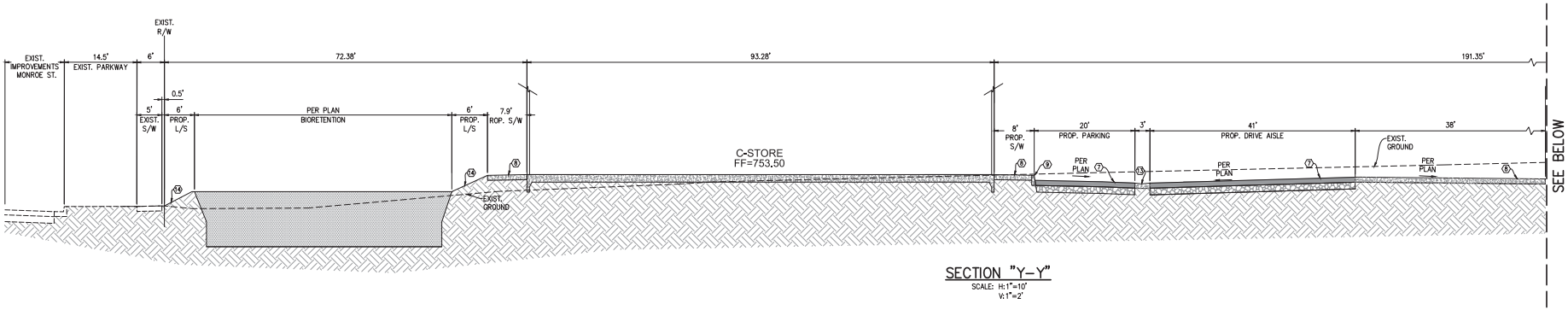
woodard group

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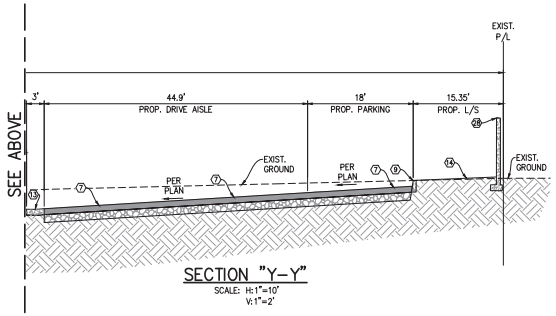
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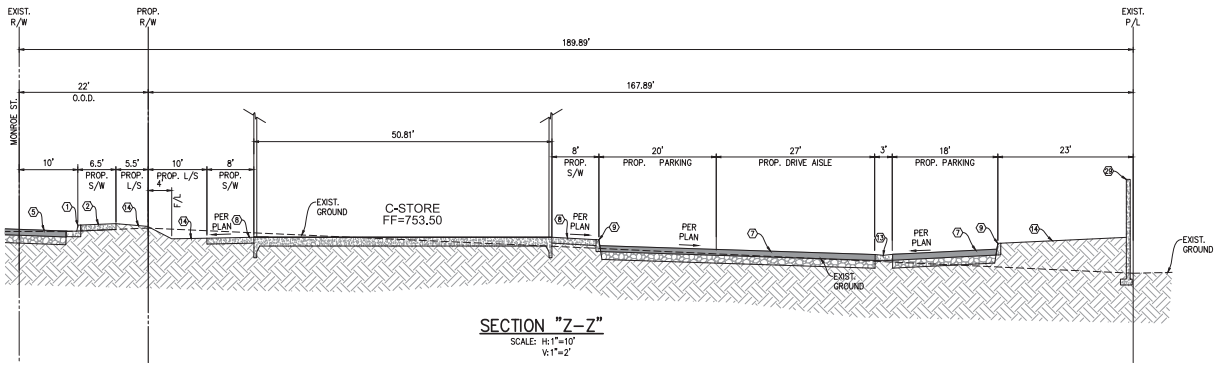
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V:1"=2'



SECTION "Y-Y"
SCALE: H:1"=10'
V:1"=2'

CONSTRUCTION NOTES

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SECTION "Z-Z"
SCALE: H:1"=10'
V:1"=2'

MARK	REVISIONS	DATE	BY

CONCEPTUAL GRADING PLAN
6892 ARLINGTON AVENUE
SECTIONS

FOR: STEVEN WALKER COMMUNITIES

SCALE:	AS SHOWN
DATE:	03/2024
DESIGNED:	AW
CHECKED:	AW
PLN CK REF:	
F.B.	

woodard group

W.O.
SHEET 3
OF 3 SHEETS
DWG. NO. 1103

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Appendix 3: Soils Information

Geotechnical Study and Other Infiltration Testing Data

GeoMat Testing Laboratories, Inc.

Soil Engineering, Environmental Engineering, Materials Testing, Geology

April 24, 2020

Project No.: 20112-01

TO: Steven Walker Communities
7111 Indiana Avenue, Suite 300
Riverside, California 92504

SUBJECT: Preliminary Soil Investigation Report, Proposed Commercial Development, SEC of Arlington Avenue and Monroe Street, APN: 191-150-031, 032 & 033, Riverside, California

In accordance with your authorization, GeoMat Testing Laboratories, Inc. (GeoMat) is pleased to present our Preliminary Soil Investigation Report for the proposed commercial development at APN: 191-150-031, 032 & 033 at the southeast corner of Arlington Avenue and Monroe Street, in the City of Riverside, California. This report is in fulfillment of our proposal dated April 13, 2020 and your subsequent authorization. The accompanying report presents a summary of our findings, recommendations, and limitation of work for the proposed site development.

The primary purpose of our investigation and report is to provide an evaluation of the existing geotechnical conditions at the site as they relate to the design and construction of the proposed commercial building(s). More specifically, this investigation was primarily to address the following potential geotechnical conditions:

- Site Excavatability
- Temporary Excavation Recommendations
- Earthwork Recommendations
- Shallow Foundation and Slab-on-Grade Recommendations
- Retaining Wall Design Recommendations
- Pavement Recommendations
- Soil Infiltration Testing Rates

If you should have any questions regarding this report, please do not hesitate to call our office. We appreciate this opportunity to be of service.

Submitted for GeoMat Testing Laboratories, Inc.

Haytham Nabilsi, GE 2375
Project Engineer, Exp. 12/31/2020

LICENSED PROFESSIONAL ENGINEER
HAYTHAM NABILSI
GE 2375
GEOTECHNICAL
STATE OF CALIFORNIA

Art Martinez
Staff Engineer

Distribution: (3) Addressee

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Plate 2 Typical Retaining Wall Drainage Detail
Plate 3 Typical Permeable Pavement Detail
Plate 4 Typical Stormwater Planter Detail

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Appendix E Liquefaction Analysis
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1.0 INTRODUCTION

1.1 EXISTING SITE CONDITIONS

The subject site is located on the southeastern corner of Arlington Avenue and Monroe Street, in the City of Riverside, California. The site is bordered to the north and west by Arlington Avenue and Monroe Street, respectively and to the south and east by residential properties. Access onsite can be made from either Arlington Avenue or Monroe Street. Arlington Avenue is a fully developed street but with concrete curb and gutter improvements limited to the eastern half of the property. Monroe Street is a fully developed street with existing concrete curb and gutter. The geographical relationship of the site and surrounding vicinity is shown on the Site Location Map, Figure 1.

The site is roughly rectangular in shape measuring approximately 330 feet long and 170 feet wide. The site is currently vacant, covered mostly in light seasonal grasses and several mature trees. The existing grades onsite are generally level without any abrupt major grade changes. Previously, a structure was located in the center of the property that was removed prior to 2002.

1.2 PROPOSED DEVELOPMENT

We have not been provided with any site plans but we understand that the site is proposed for a commercial development. The development will consist of one to several commercial buildings with associated concrete hardscape, AC pavement drive lanes/parking spaces, and landscaping.

No structural details or foundation plans were provided for our review at the time of this report. We assume that the commercial building will be constructed at or near existing grade (no basements) and supported on shallow concrete foundation with slab-on-grade. Continuous wall loads will not exceed 2 kips per linear foot and isolated column loads of up to 30 kips.

Once the design phase and foundation loading configuration proceeds to a more finalized plan, the recommendations within this report should be reviewed and revised, if necessary. Any changes in the design, location or elevation of any structure, as outlined in this report, should be reviewed by this office. GeoMat should be contacted to determine the necessity for review and possible revision of this report.

1.3 FIELD WORK

Three exploratory boreholes were drilled up to 50 feet below ground surface on April 16, 2020 utilizing a CME-75 mobile drill rig equipped with 8-inch diameter hollow stem augers. Refer to Plate 1 for borehole locations.

Relatively undisturbed samples were obtained with the California Ring Sampler (ASTM D 1587). This sampler has three inches external diameter, 2.5-inches inside diameter, and is lined with 1-inch high brass rings, with an inside diameter of 2.41-inches. The sample barrel is driven into the ground at the bottom of the boring with 140-pound hammer with a free fall of approximately 30-inches. Sampler driving resistance, expressed as blows per six inches of penetration, is presented on the boring logs at the respective sampling depths. Ring samples were retained in close-fitting, moisture tight canisters for transport to our laboratory for testing.

Additional representative samples have been recovered with the SPT (Standard Penetration Test, ASTM D 1586) sampler. This sampler consists of steel driving shoe and tube that split longitudinally in half, and a coupling at the top. The coupling connects the sampler to the drill rod. The standard split tube has an inside diameter of 1 3/8-inch (1 1/2-inch inside diameter without liners) and an outside diameter of 2-inches. Unless noted otherwise, liners are usually not used. The standard driving weight and free fall for this test is similar to California Ring Sampler. Blow counts required to drive the samplers 18-inches are recorded on the boring logs. The sum of the number of blows for the last 12-inches on an 18-inch penetration represents the SPT count. This data is shown on the boring logs when obtained in the field.

Bulk samples were also collected from the auger cuttings during drilling. The samples were collected in plastic bags, tied, and tagged for the location and depth. The geotechnical boring logs are presented in Appendix B and may include a description and classification of each stratum, sample locations, blow counts, groundwater conditions encountered during drilling, results from selected types of laboratory tests, and drilling information.

1.4 SUBSURFACE FINDINGS

According to the Geologic Map of the Riverside West/South 1/2 of Fontana Quadrangles (Dibblee Foundation Map DF-128), the subject site is underlain by older alluvial fan deposits (Qoa). Alluvium is weathered bedrock material and sediments that have been eroded from natural slopes and deposited in generally flat lying areas.

Based on our exploratory borings, this alluvial soil generally consists of medium dense to very firm clayey sand (USCS “SC”) and sandy lean clay (USCS “CL”). Bedrock was encountered in all three exploratory borings at depths generally between 5 and 10 feet below ground surface. The bedrock is mapped as quartz diorite (qdi) of the peninsular ranges.

1.5 GROUNDWATER CONDITIONS

Groundwater study is not within the scope of this work. Groundwater was encountered in all of our exploratory borings between 15 and 25 feet below existing ground surface. During the infiltration testing, several days later, standing water was observed in the percolation test holes P-1 and P-2 at 7 feet below ground surface.

A contour map showing minimum depths to ground water in the Santa Ana River Valley Region was constructed by the United States Geological Survey (USGS) and subsequently, a report (USGS Map MF-1802) was published in 1985. The map was constructed by contouring the shallowest water level measurements reported to the California Department of Water Resources (CDWR) for the period from 1973-1979. Based on our review of the map, the minimum depth to ground water in the project site area, during this period, was indicated to be around 10 feet below ground surface.

Please note that the potential for rain or irrigation water locally seeping through from elevated areas and showing up near grades cannot be precluded. Our experience indicates that surface or near-surface groundwater conditions can develop in areas where groundwater conditions did not exist prior to site development, especially in areas where a substantial increase in surface water infiltration results from landscape irrigation. Fluctuations in perched water elevations are likely to occur in the future due to variations in precipitation, temperature, consumptive uses, and other factors including mounding of perched water over bedrock or natural soil. Mitigation for nuisance shallow seeps moving from elevated lower areas will be needed if encountered. These mitigations may include subdrains, horizontal drains, toe drains, french drains, heel drains or other devices.

1.6 LABORATORY TESTING

Laboratory tests were performed on selected soil samples collected throughout our subsurface investigation. The tests consisted primarily of moisture content, dry density, sieve analysis, direct shear, hydrocollapse, expansion potential, and water soluble sulfate content. The soil classifications are in conformance with the Unified Soil Classifications System (USCS), as outlined in the Classification and Symbols Chart (Appendix B). A summary of our laboratory testing, ASTM designation, and graphical presentation of test results is presented in Appendix C.

2.0 GEOTECHNICAL HAZARDS

We have reviewed the potential geotechnical hazards at the subject site and have summarized our findings in the following table.

SUMMARY OF POTANTIAL GEOTECHNICAL HAZARDS

HAZARD	ONSITE?	COMMENT
Regional and Local Faults	No	There are no mapped active or potentially active faults with surface expression that trend through or are adjacent to the subject property based on the references cited. The site does not lie within a designated Alquist-Priolo Earthquake Fault Zone (CDMG, 2000).
Seismic Ground Shaking	Yes	The subject site, as is the case with most of the tectonically-active Southern California area, will be periodically subject to moderate to intense earthquake-induced ground shaking from nearby faults. Considerable damage can occur to the site and structural improvements during a strong seismic event. Neither the location nor magnitude of earthquakes can accurately be predicted at this time.
Liquefaction, lateral spreading, and Seismic Settlement*	Yes	According to the City of Riverside General Plan, the site is located in an area considered to be susceptible to liquefaction. Therefore, the potential for liquefaction and dynamic settlement has been evaluated as outlined in Chapter 6 of the California Division of Mines and Geology (DMC) Special Publication 117 ("Guidelines for Evaluation and Mitigation of Seismic Hazards in California") and "Recommended Procedures for Implementation of DMG Special Publication 117 - Guidelines for Analyzing and Mitigating Liquefaction in California", published by the Southern California Earthquake Center, 2008 edition. The design and construction recommendations presented in this report include results of liquefaction and dynamic settlement evaluation. The analysis results are included in Appendix E.
Slope Stability	No	There are no slopes on the subject site or adjacent properties and no slopes are proposed.
Expansive Soil	No	Based on laboratory testing, the upper foundation soil onsite is expected to have a very low expansion potential (EI<20), as defined in ASTM D4829. This would require verification subsequent to completion of new footing excavations.
Collapsible Soil	No	A soil sample, representing the upper ten feet of native soil, was tested in the laboratory for collapse potential. Test results indicate that less than 1% of hydro-collapse occurred in the tested samples. Therefore, the severity of hydrocollapse potential onsite is considered "No Problem" based on NAVFAC DM7.01, see Appendix C for Results.
Corrosive Soil	No	To preliminarily assess the sulfate exposure of concrete in contact with the site soils, a representative soil sample was tested for water-soluble sulfate content. The test results suggest the site soils have a negligible potential for sulfate attack (0.0165 percent) based on commonly accepted criteria. We recommend following the procedures provided in ACI 318-19, Section 19.3, Table 19.3.2.1 for exposure "S0". We recommend Type II cement for all concrete work in contact with soil.
Caving Potential	No	The onsite soil is composed of older alluvial soil and relatively shallow bedrock which is expected to have a low potential for caving.

*The analysis indicates that total dynamic settlement is negligible (0.01 inches) during a large earthquake episode. An estimated dynamic differential settlement of 0.01-inch may be anticipated. The historical high ground water during a seismic event has been assumed at ground surface.

Based on SCEC (1999) guidelines, a potential for loss of bearing capacity due to liquefaction is not expected at the site since there is not an upper potentially liquefiable layer at a depth shallower than the estimated depth where the induced vertical stress in the soil is 10% of the bearing pressure imposed by the proposed foundation systems.

In significant conformance with Youd, Hanson, and Bartlett (ASCE Geotechnical Jr. April 1995, and Lecture by Youd on July 7, 1999), no lateral spreading due to liquefaction is expected at this site due to the following reasons:

- Alluvial subsurface soils are essentially horizontally layered.
- There is not a free-face, onsite, toward which liquefied soils could move laterally.
- No saturated liquefiable sand with values of N1(60) <15 exist at the site.

If loose clean sand exists between sampling intervals, their occurrence is expected to be thin and considered to be scattered or have minimal occurrence throughout the site, and cannot reasonably be connected to form a hypothetical "continuous" line of significant length that could reasonably be expected to "exit" on a slope or a free-face, or move significantly below the gentle slope of the site.

Although it is extremely difficult to predict the overall behavior of any site during seismic shaking, it is our opinion that proper design of foundation can substantially improve the structure's resistance to deformation. This is most commonly accomplished by providing adequate lateral connections between all footings with reinforced grade beams and strengthened stem walls. If the owner wishes a higher degree of confidence, then the structures should be designed for higher probable events.

Please note that foundation design is under the purview of the structural engineer. All foundations should be designed by a qualified structural engineer in accordance with the CBC and the latest applicable building codes and structural considerations may govern.

2.1 SOIL SITE CLASS

The subsurface soil profile at the site can be classified from a seismic standpoint based on the conditions encountered in our exploratory borings, and anticipated within the upper 100 feet of the site based on geologic mapping, as being "very dense soil and soft rock" with an average undrained shear strength (s_u) of more than 2,000 psf and SPT N-values of more than 50 blows per foot. Based on the soils encountered in the borings drilled within the subject site and with consideration of the geologic units mapped in the area, it is our opinion that the site soil profile corresponds to Site Class C in accordance with Section 1613.2.2 of the California Building Code (CBC 2019) and Chapter 20 of ASCE/SEI 7-16.

2.2 SEISMIC DESIGN PARAMETERS:

We have determined the seismic design parameters in accordance with the provisions of the current California Building Code (CBC, 2019) and ASCE/SEI 7-16 Standard using the Structural Engineers Association of California, OSHPD Seismic Design Maps Web Application (https://seismicmaps.org). The CBC Site Class was determined to be Site Class "C" based on the results of our explorations and a review of the local soil and geologic conditions. The mapped seismic parameters are presented in Appendix D of this report.

The 2019 CBC requires that Site Class F be assigned to any profile containing soils vulnerable to potential failure or collapse under seismic loading, such as liquefiable soils. For Site Class F, the site coefficients are to be determined in accordance with Section 11.4.8 of ASCE/SEI 7-16. However, Section 20.3.1 of ASCE/SEI 7-16 indicates that for sites with structures having a fundamental period of vibration equal to or less than 0.5 seconds, the site coefficient factors (F_a and F_v) may be determined using the standard procedures.

The seismic design parameters provided in this report were calculated using the site coefficient factors for Site Class C, assuming that the fundamental periods of the structures are less than 0.5 seconds. However, the results of the liquefaction evaluation indicate that the subject site is underlain by potentially liquefiable soils. If the proposed structure has a fundamental period greater than 0.5 seconds, a site specific seismic hazards analysis will be required and additional subsurface exploration will be necessary.

2.3 GEOTECHNICAL CONCLUSION

Based on the findings summarized in this report, it is our professional opinion that the proposed development will not be subject to a hazard from settlement, slippage, or landslide, provided the recommendations of this report are incorporated into the proposed development. It is also our opinion that the proposed development will not adversely affect the geologic stability of the site or adjacent properties provided the recommendations contained in this report are incorporated into the proposed construction.

3.0 TENTATIVE RECOMMENDATIONS

3.1 SITE PREPARATION

All grading should be performed in accordance with our General Earthwork and Grading Specifications presented in Appendix F except as modified within the text of this report.

3.1.1 Clearing, Grubbing, & Fill Removal

All debris, undocumented fill, abandoned utility lines, roots, irrigation appurtenances, underground structures, deleterious materials, etc., should be removed and hauled offsite. Cavities created during site clearance should be backfilled in a controlled manner.

3.1.2 Overexcavation & Subgrade Preparation

Overexcavation and recompaction is recommended to replace the existing surficial soils and to reduce the potential for excessive settlement of the onsite soils. Care should be taken during overexcavation operations to maintain sidewall stability and personal safety.

The recommended overexcavations described below may be extended deeper if loose soil is encountered in the bottom of the overexcavation. Once the bottom of the excavation is observed by a representative of this office to be in competent native soil, the bottom of the overexcavation should be scarified, moisture conditioned, and recompacted to at least 90 percent of the maximum dry density, as determined by ASTM D1557 Test Method; prior to placement of fill. Deeper overexcavations, especially to remove loose soils or deleterious material, may be required depending upon field observations of excavation bottom by the soil engineer or his representative.

3.1.2.1 Building Pad

Subsequent to site clearance, the proposed building pad should be overexcavated to a depth of at least 5 feet below existing grade or 3 feet below the proposed footings, whichever is greater. The lateral extent of the overexcavations should be the greater of 5 feet beyond building lines or equal to the depth of fill, where possible.

3.1.2.2 Retaining and Screening Walls

If proposed, screening and retaining walls should be overexcavated to a depth of 2 feet below foundation bearing grade and replaced as compacted structural. Any undocumented fill soils or disturbed native alluvium within any of these foundation areas should be removed in their entirety. The overexcavated subgrade soils should be evaluated by the geotechnical engineer prior to scarifying, moisture conditioning, and recompacting. The previously excavated soils may then be replaced as compacted structural fill. The subgrade preparation should extend beyond the proposed improvements a horizontal distance of at least 2 feet, where achievable.

3.1.2.3 Pavement and Hardscape Subgrade

Subsequent to site clearance, pavement and hardscape areas should be overexcavated to a depth of at least 2 feet below proposed finish grade or existing grade, whichever is greater. The subgrade preparation should extend beyond the proposed improvements a horizontal distance of at least 2 feet, where achievable. The excavation bottom should be scarified 8 inches, moisture conditioned to near optimum moisture content and be recompacted to at least 90% relative compaction. Engineered fill should then be moisture conditioned, placed in suitable lifts, and compacted to a minimum of 90% relative compaction. Aggregate base should be compacted to at least 95 percent of the maximum dry density as determined by ASTM D1557

3.1.3 Compacted Fills/Imported Soils

Any soil to be placed as fill, whether presently onsite or import, should be approved by the soil engineer or his representative prior to their placement. All onsite soils to be used as fill should be cleansed of any roots, or other deleterious materials. Rocks larger than 8-inches in diameter should be removed from soil to be used as compacted fill.

All fills should be placed in 6- to 8-inch loose lifts, thoroughly watered, or aerated to near optimum moisture content, mixed and compacted to at least 90 or 95 percent relative compaction depending on the material (subgrade soil or aggregate base) and application (pavement subgrade, building pad, etc.). This is relative to the maximum dry density determined by ASTM D1557 Test Method.

Any imported soils should be sandy (preferably USCS "SM" or "SW", and very low in expansion potential) and approved by the soil engineer. The soil engineer or his representative should observe the placement of all fill and take sufficient tests to verify the moisture content and the uniformity and degree of compaction obtained. should be designated to allow for variations in the indicated shrinkage and subsidence estimates.

3.1.4 Trench Backfill

All utility trenches and retaining wall backfills should be mechanically compacted to the minimum requirements of at least 90 percent relative compaction. Onsite soils derived from trench excavations can be used as trench backfill except for deleterious materials. Soils with sand equivalent greater than 30 may be utilized for pipe bedding and shading. Pipe bedding should be required to provide uniform support for piping. Excavated material from footing trenches should not be placed in slab-on-grade areas unless properly compacted and tested.

3.2 TEMPORARY EXCAVATIONS

All excavations must comply with applicable local, state, and federal safety regulations including the current OSHA Excavation and Trench Safety Standards. Construction site safety generally is the sole responsibility of the Contractor, who should also be solely responsible for the means, methods, and sequencing of construction operations.

3.2.1 Excavation Characteristics

The onsite soil is generally composed of dense to hard clayey sand and sandy lean clay which may exhibit difficult excavating resistance for smaller excavating equipment such as rubber-tired backhoes.

3.2.2 Safe Vertical Cut

All applicable requirements of the California Construction and general Industry Safety Orders, the Occupational Safety and Health Act, and current amendments, and the Construction safety Act should be met. Cuts should be observed during excavation by the project's geotechnical consultant. If potentially unstable soil conditions are encountered, modifications of slope ratios for temporary cuts may be required.

Temporary un-surcharged excavations of 4 feet high may be made at a vertical gradient for short periods of time. Temporary un-surcharged excavations greater than 4 feet may be trimmed back at 1H:1V gradients.

The exposed vertical cut conditions should be verified by the project geotechnical engineer during construction. No excavations should take place without the direct supervision of the project geotechnical engineer.

3.2.3 Excavation Setbacks

No excavations should be conducted, without special considerations, along property lines, public right-of-ways, or existing foundations, where the excavation depth will encroach within the "zone of influence". The "zone of influence" of the existing footings, property lines, or public right-of-way may be assumed to be below a 45-degree line projected down from the bottom edge of the footing, property line, or right-of-way.

3.2.4 Precaution for Excavations

The Contractor should be aware that unsupported excavation depths should in no case exceed those specified in local, state, and/or federal safety regulations (e.g., OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, or successor regulations).

Such regulations are strictly enforced and, if they are not followed, the Owner, Contractor, and/or earthwork and utility subcontractors could be liable for substantial penalties. The contractor's "responsible person", as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures.

3.3 FOUNDATION RECOMMENDATIONS

The proposed building may be supported on conventional shallow foundation systems deriving support in compacted fill. All foundation excavations must be observed and approved by the Geotechnical Engineer's representative, prior to placing steel reinforcement or concrete.

3.3.1 Bearing Value

Spread, continuous, or pad-type foundations carried at least 18-inches below the lowest adjacent grade may be designed to impose a net dead-plus-live load pressure of 2,500 psf. The bearing capacity may be increased 15 percent for every additional foot of embedment, to a maximum allowable bearing pressure of 3,000 psf. A one-third increase may be used for wind or seismic loads.

3.3.2 Lateral Resistance

Resistance to lateral footing will be provided by passive earth pressure and base friction. For footings bearing against firm native material, passive earth pressure may be considered to be developed at a rate of 260 psf per foot of depth to a maximum of 2,000 psf. Base friction may be computed at 0.38 times the normal load. If passive earth pressure and friction are combined to provide required resistance to lateral forces, the value of the passive pressure should be reduced to two-thirds the value.

3.3.3 Total Settlement

The onsite soils below the foundation depth have relatively high strengths and will not be subject to significant stress increases from foundations of a new structure. Therefore, estimated total long-term static and seismic settlement between similarly loaded adjacent foundation systems should not exceed 1-inch. The structures should be designed to tolerate a differential settlement on the order of 1/2-inch over a 30-foot span, thereby resulting in an angular distortion of less than 0.002 inches per inch.

3.3.4 Reinforcement

Footing reinforcement should be determined by the structural engineer; however, minimum reinforcement should be at least two No. 5 reinforcing bars, top and bottom. Reinforcement and size recommendations presented in this report are considered the minimum necessary for the soil conditions present at the foundation level and are not intended to supersede the design of the project structural engineer or criteria of the governing agencies for the project.

3.4 SLABS-ON-GRADE

Office slabs should be at least 4-inches thick. Storage slabs and slabs subject to traffic should be at least 6-inches thick. The structural engineer should design the actual slab thickness and reinforcement based on structural load requirements.

3.4.1 Modulus of Subgrade Reaction

A coefficient of vertical subgrade reaction (K_V) of 120 psi/in may be assumed for the building pad compacted fill soils. The modulus of subgrade reaction was estimated based on the NAVFAC 7.1 design charts. This value is for a small loaded area (1 sq. ft or less) such as for wheel loads or point loads and should be adjusted for larger loaded areas, as necessary.

3.4.2 Capillary Break & Moisture Barrier

If moisture sensitive floor coverings are proposed, we recommend that the floor slab in those areas be underlain by a minimum 10-mil visqueen moisture barrier, or equivalent, over a 2-inch thick capillary break layer of clean sand. The 2-inch thick layer of sand should be placed between the subgrade soil and the membrane to decrease the possibility of damage to the membrane. The moisture vapor barrier should be properly constructed in accordance with all applicable manufacturer specifications.

3.4.3 Slab Curling

A low-slump concrete should be used to minimize possible curling of the slab. A 2-inch thick layer of sand may be placed over the vapor retarding membrane to reduce slab curling. If this sand bedding is used, care should be taken during the placement of the concrete to prevent displacement of the sand. The concrete slab should be allowed to cure properly before placing vinyl or other moisture-sensitive floor covering.

However, the need for sand and/or the amount of sand above the moisture vapor barrier should be specified by the structural engineer or concrete contractor. The selection of sand above the barrier is not a geotechnical engineering issue and hence outside our purview.

3.4.4 Subgrade Exposure

Construction activities and exposure to the environment can cause deterioration of the prepared subgrade. Therefore, we recommend that our field representative observe the condition of the final subgrade soils immediately prior to slab-on-grade construction, and, if necessary, perform further density and moisture content tests to determine the suitability of the final prepared subgrade.

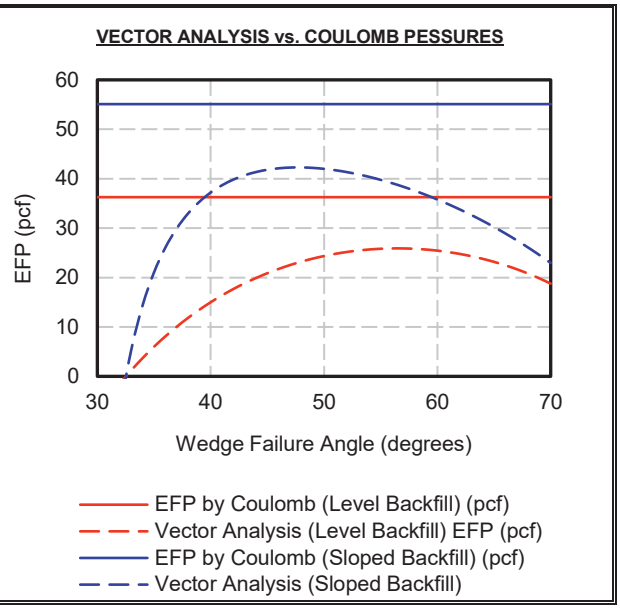
Additionally, the slab subgrade should be moisture conditioned to 2 to 4 percent above the optimum moisture content, to a depth of 12 inches. The moisture content of the floor slab subgrade soils should be verified by the geotechnical engineer within 24 hours prior to placing the vapor retarding membrane or concrete.

3.5 RETAINING WALLS

The following lateral earth pressures, in conjunction with the lateral resistance parameters provided in the Foundation Recommendations section of this report, may be used for the design of retaining walls with free draining compacted backfills. If passive earth pressure and friction are combined to provide required resistance to lateral forces, the value of the passive pressure should be reduced to two-thirds the following recommendations.

Earth Pressure Condition	Backfill Slope	Equivalent Fluid Pressure (pcf)	Earth Pressure Coefficient
Active Case (Fully Drained)	Level	36	K_a = 0.30
	2H:1V	55	K_a = 0.46
At-Rest Case (Fully Drained)	Level	56	K_o = 0.46
	2H:1V	81	K_o = 0.67
Total Unit Weight of Soil		120 pcf	

The lateral earth pressures presented in the table above were determined by comparing the calculated earth pressures utilizing the classical methods presented by Coulomb (active case) and Jaky (at-rest case) with the free-body diagram method (vector analysis) and the greater value is the governing design value.



All retaining walls and block walls footings should be founded in compacted fill or firm native soils. We recommend drainage for retaining walls to be provided in accordance with Plate 2 of this report. Maximum precautions should be taken when placing drainage materials and during backfilling. All wall backfills should be properly compacted to at least 90 percent relative compaction. We also recommend that a waterproofing specialist provide any recommendations and design of a waterproofing system.

3.6 CONVENTIONAL PAVEMENT RECOMMENDATIONS

3.6.1 Subgrade Uniformity

The proposed pavement subgrade should be prepared in accordance with the Overexcavation & Subgrade Preparation section of this report. The subgrade for pavement support must be firm, unyielding, and uniform with no abrupt horizontal changes in degree of support. The subgrade soil should be uniform materials and density. Soft spots, if encountered, should be excavated and recompacted with the same type of soil as found in adjacent subgrade.

3.6.2 Aggregate Base

The aggregate base should conform to Caltrans Class 2 Aggregate Base or the Standard Specifications for Public Works for Crushed Miscellaneous Base, should be firm and unyielding, and without pumping conditions prior to placement of pavement. Aggregate base should be compacted to at least 95 percent of the maximum dry density as determined by ASTM D1557.

3.6.3 Flexible Pavement Design

The following recommended pavement section is based on the following assumed Traffic Index and R-value. The minimum recommended asphalt concrete (AC) pavement thickness is as follows:

Location	Traffic Index (Assumed)	R-Value (Assumed)	Minimum Recommended Pavement Section	
			AC	AB
Auto Parking	5	10	3.0”	9.0”
Heavy Truck Traffic	7	10	4.0”	14.5”

AC: Asphalt Concrete, AB: Aggregate Base,

Final pavement design recommendations should be based on laboratory test results of representative pavement subgrade soils upon the completion of rough grading.

3.6.4 Portland Cement Concrete

For interior private drives, 8-inches minimum concrete over compacted native subgrade is recommended. Pavement subgrade should be saturated to a depth of 12-inches and compacted to at least 95 percent relative compaction. Saturated subgrade should be tested for moisture by the soil engineer.

Concrete pavement should be air entrained Portland Cement Concrete Pavement and must have a minimum 28-day flexural strength of 450 psi (compressive strength of approximately 3500 psi).

No reinforcing is necessary. Joint design and spacing should be in accordance with ACI recommendations. Construction joints should contain dowels or be tongue and grooved to provide load transfer. Tie bars are recommended on the joints adjacent to unsupported edges. Maximum joint spacing in feet should not exceed 2 to 3 times the thickness in inches. Joint sealing with a quality silicone sealer is recommended to prevent water from entering the subgrade allowing pumping and loss of support.

Proper subgrade preparation and joint sealing will reduce (but not eliminate) the potential for slab movements (thus cracking) on native soils. Frequent jointing will reduce uncontrolled cracking and increase the efficiency of aggregate interlock joint transfer.

3.7 PERVIOUS PAVEMENTS (OPTIONAL)

As an alternative option for managing stormwater run-off, the onsite system may also utilize permeable pavement options. The type of pavement should be selected based on a review of the pavement specifications and properties and designed according to the product manufacturer's recommendations. The permeable pavement should be designed in accordance with the Riverside County Design Handbook for Low Impact Development Best Management Practices (http://rcflood.org/npdes/LIDBMP.aspx). Refer to Plate 3 for a typical permeable pavement detail.

3.7.1 Pervious Cement Concrete Pavement

In order to provide porous concrete pavement recommendation, we started by estimating the conventional concrete pavement thickness. Once the conventional concrete thickness is known, we add 1.5 inches to the conventional thickness to obtain the porous pavement thickness for a Modulus of Rupture of 375 psi.

3.7.1.1 Storing Stormwater for Evaporation

This pavement option is for storing storm water in the pavement voids until evaporation. Thicker concrete may be utilized to ensure sufficient void space to accommodate the volume of water generated during a storm event.

	Porous Concrete Thickness	Impermeable Liner	Aggregate Base	Subgrade
Option I	9.5" (min)	15 mil (min)	--	95% Compacted
Option II	9.5" (min)	--	4" Class II	90% Compacted

3.7.1.2 Storing Stormwater for Infiltration

This option is for storing storm water in the gravel reservoir voids until water infiltrates into the soil. The recommend thickness of porous concrete is at least 5.5 inches. We recommend to install a reservoir layer consists of stone underneath the structural pavement. The total thickness of the reservoir layer is determined by runoff storage needs and the infiltration rate of in situ soils. A 12" maximum reservoir layer consisting of AASHTO #57 washed gravel vibrated in place or equivalent with a minimum of 40% void ratio should be utilized.

The reservoir layer should be lightly compacted to a firm unyielding condition. Over-compaction of the reservoir layer can result in reduced permeability. The prepared reservoir layer should be observed by an engineer to ensure that it has been adequately compacted prior to placement of the permeable pavement section.

If treatment of the collected stormwater is necessary before infiltration, a minimum 6-inch thick filter layer of sand or permeable treatment media could be included in the pavement section and located below the permeable reservoir.

3.7.2 Porous Asphalt Concrete Pavement

This option is for storing storm water in the reservoir voids below asphalt concrete porous pavement until water infiltrates into the soil. We recommend the porous asphalt to be at least 4 inches thick underlain with a reservoir layer. A 12" maximum reservoir layer consisting of AASHTO #57 washed gravel vibrated in place or equivalent with a minimum of 40% void ratio may be utilized. The total thickness of the reservoir layer is determined by runoff storage needs and the infiltration rate of in situ soils.

The reservoir layer should be lightly compacted to a firm unyielding condition. Over-compaction of the reservoir layer can result in reduced permeability. The prepared reservoir layer should be observed by an engineer to ensure that it has been adequately compacted prior to placement of the permeable pavement section.

If treatment of the collected stormwater is necessary before infiltration, a minimum 6-inch thick filter layer of sand or permeable treatment media could be included in the pavement section and located below the permeable reservoir.

3.7.3 Maintenance

All porous pavement should be inspected twice a month for three months after construction, and annually thereafter. Inspections should be conducted after large storms to check for ponding that might indicate local clogging. In addition, it is also important to frequently inspect pavement for debris, mud, and vegetation growth. The pavement should be designed to flow in case of run off producing event.

3.8 STORMWATER INFILTRATION

Infiltration testing was conducted utilizing the shallow percolation test method at depths of 2, 3 and 9 feet below existing ground surface. The infiltration testing was performed in general accordance with the guidelines published in the Riverside County Design Handbook for Low Impact Development Best Management Practices, Infiltration Testing Guidelines. The following table summarizes the result of the infiltration feasibility study. Refer to Appendix G for field infiltration test data.

Test No.	Test Depth Below Ground Surface	Adjusted Infiltration Rate (in/hr)
P-1	36"	3.25
P-2	24"	2.40
P-3	108"	0.05
P-4	108"	0.28

The raw percolation rate is the rate of water infiltration in the horizontal and vertical direction. This percolation rate is adjusted using the "Porchet Method" to obtain the adjusted water infiltration rate in the vertical direction only.

Long-term infiltration rates may be reduced significantly by factors such as soil variability and inaccuracy in the infiltration rate measurement. The correction factor for site variability is between 3 and 10. Safety factors for operating the system, maintenance, siltation, biofouling, etc. should also be considered by the design civil engineer at his discretion. Minimum safety factor required by the County of Riverside for tests conducted when deep exploratory borehole has been drilled at the site is 3.

The soil infiltration results were inconsistent with soil classification. Additionally, groundwater elevation varied significantly several days after drilling. Infiltration in older alluvium (soil above granitic material) is expected to be much slower that the results obtained. Infiltration is expected to be good in weathered granitic material estimated to be the upper four to five feet. Caution should be exercised when encroaching groundwater levels. The depth to groundwater levels will vary depending on a variety of conditions including season, irrigation activities and rainfall events. Groundwater mounding (localized rising of groundwater level due to concentration of stormwater infiltration) may be estimated once the location and size of infiltration facility is known.

The infiltration system must be located such that the closest distance between an adjacent foundation is at least 10 feet in all directions from the zone of saturation. The zone of saturation may be assumed to project downward from the discharge of the infiltration facility at a gradient of 1H:1V. Additional property line or foundation setbacks may be required by the governing jurisdiction and should be incorporated into the stormwater infiltration system design as necessary.

However, due to the relatively shallow groundwater at the subject site (7 feet below ground surface) an alternative isolated system located within the landscape areas may be utilized. Isolation should consist of a barrier, such as a planter box, that prevents water from passing through to the site soils. The filtration system may consist of soil media underlain by an underdrain system with a geotextile fabric. Refer to Plate 4 for a typical stormwater planter detail.

3.9 SITE DRAINAGE

Positive drainage should be provided and maintained for the life of the project around the perimeter of all structures (including slopes and retaining walls) and all foundations toward streets or approved drainage devices to minimize water infiltrating into the underlying natural and engineered fill soils. In addition, finish subgrade adjacent to exterior footings should be sloped down (at least 2%) and away to facilitate surface drainage. Perimeter water collection devices may be installed around the structure to collect roof/irrigation/natural drainage. Roof drainage should be collected and directed away from foundations via nonerosive devices. Over the slope drainage must not be permitted.

Water, either natural or by irrigation, should not be permitted to pond or saturate the foundation soils. Planter areas and large trees adjacent to the foundations are not recommended. All planters and terraces should be provided with drainage devices. Internal drainage should be directed to approved drainage collection devices.

Location of drainage device should be in accordance with the design civil engineer's drainage and erosion control recommendations. The owner should be made aware of the potential problems, which may develop when drainage is altered through construction of retaining walls, patios and other devices. Ponded water, leaking irrigation systems, over watering or other conditions which could lead to ground saturation should be avoided. Surface and subsurface runoff from adjacent properties should be controlled. Area drainage collection should be directed through approved drainage devices. All drainage devices should be properly maintained.

4.0 ADDITIONAL SERVICES

Plan Reviews

The recommendations provided in this report are based on preliminary information and subsurface conditions as interpreted from limited exploratory boreholes at the site. We should be retained to review final grading and foundation plans to revise our conclusions and recommendations, as necessary. Professional fees will apply for each review.

Our conclusions and recommendations should also be reviewed and verified during site grading and revised accordingly if exposed geotechnical conditions vary from our preliminary findings and interpretations.

Additional Observation and/or Testing

GeoMat Testing Laboratories, Inc. should observe and/or test at the following stages of construction.

- During overexcavation and compaction of subgrade soil
- Following footing excavation and prior to placement of footing materials.
- During wetting of slab subgrade and prior to placement of slab materials.
- During all trench and wall backfill.
- When any unusual conditions are encountered.

Final Report of Compaction During Grading

A final report of compaction control should be prepared subsequent to the completion of grading. The report should include a summary of work performed, laboratory test results, and the results and locations of field density tests performed during grading.

5.0 GEOTECHNICAL RISK

The concept of risk is an important aspect of the geotechnical evaluation. The primary reason for this is that the analytical methods used to develop geotechnical recommendations do not comprise an exact science. The analytical tools which geotechnical engineers use are generally empirical and must be used in conjunction with engineering judgment and experience. Therefore, the solutions and recommendations presented in the geotechnical evaluation should not be considered risk-free and, more importantly, are not a guarantee that the interaction between the soils and the proposed structure will perform as planned.

The engineering recommendations presented in the preceding sections constitute GeoMat Testing Laboratories professional estimate of those measures that are necessary for the proposed development to perform according to the proposed design based on the information generated and referenced during this evaluation, and GeoMat Testing Laboratories experience in working with these conditions.

6.0 LIMITATION OF INVESTIGATION

This report was prepared for the exclusive use on the new construction. The use by others, or for the purposes other than intended, is at the user's sole risk.

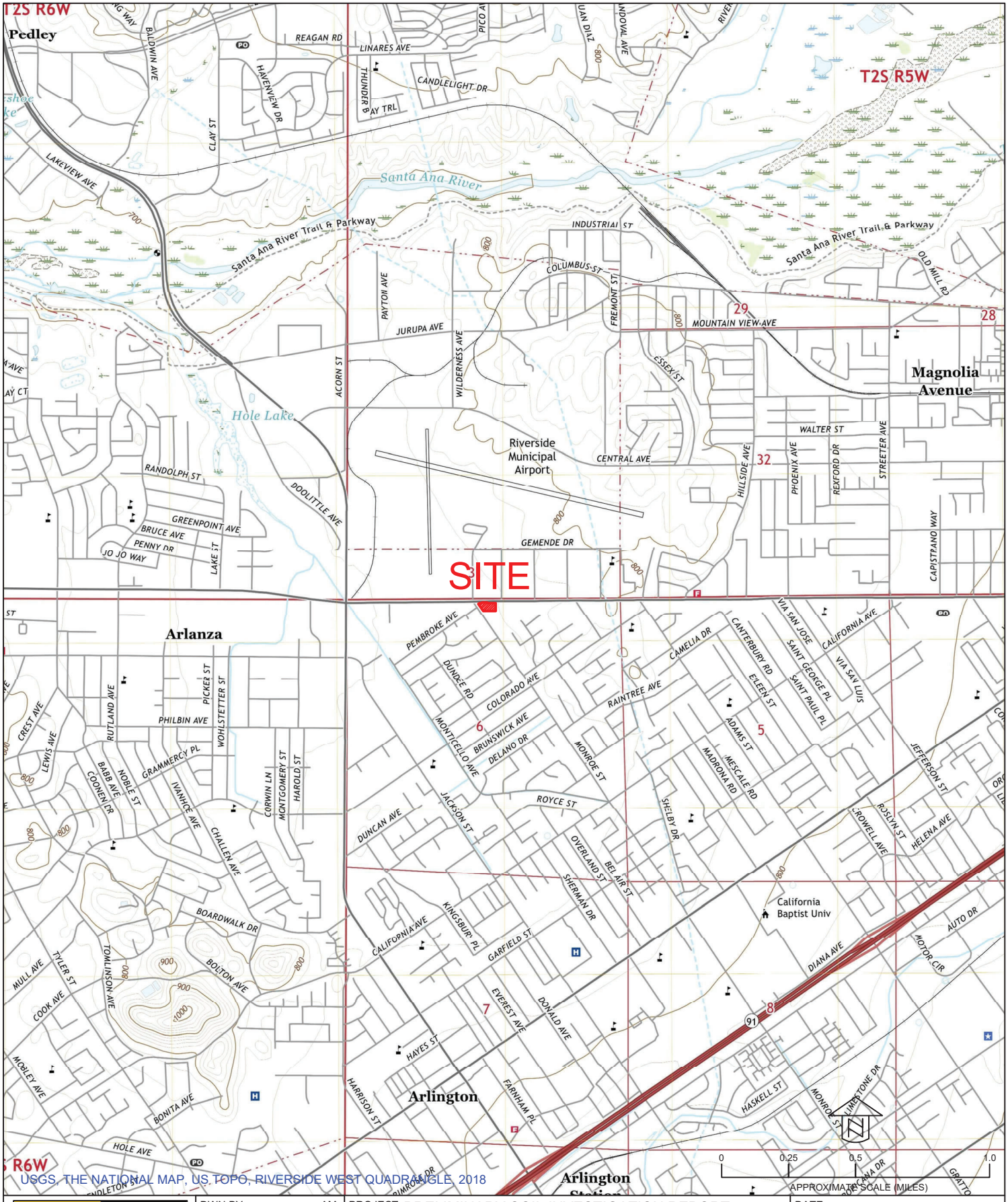
Our investigation was performed using the degree of care and skill ordinarily exercised, under similar circumstances, by reputable Geotechnical Engineers practicing in this or similar locations within the limitations of scope, schedule, and budget. No other warranty, expressed or implied, is made as to the conclusions and professional advice included in this report.

The field and laboratory test data are believed representative of the site; however, soil conditions can vary significantly. As in most projects, conditions revealed during construction may be at variance with preliminary findings. If this condition occurs, the possible variations must be evaluated by the Project Geotechnical Engineer and adjusted as required or alternate design recommended.

This report is issued with the understanding that it is the responsibility of the owner, or his representative, to ensure that the information and recommendations contained herein are brought to the attention of the engineer for the addition and incorporated into the plans, and the necessary steps are taken to see that the contractor and subcontractor carry out such recommendations in the field.

This firm does not practice or consult in the field of safety engineering. We do not direct the contractor's operations, and we cannot be responsible for other than our own personnel on the site; therefore, the safety of others is the responsibility of the contractor. The contractor should notify the owner if he considers any of the recommended actions presented herein to be unsafe.

The findings, conclusions, and recommendations presented herein are based on our understanding of the addition and on subsurface conditions observed during our site work, and are valid as of the present date. However, changes in the conditions of a property can occur with the passage of time, whether they be due to natural processes or the works of man on this or adjacent properties. In addition, changes in applicable or appropriate standards may occur, whether they result from legislation or the broadening of knowledge.



geomat GeoMat Testing Laboratories, Inc. 9980 Indiana Avenue, Suite 14 Riverside, California 92503	DWN BY: AM CHK'D BY: MN DATUM: -- PROJECTION: -- SCALE: 1" = 1/2 MILE REV. NO.: --	PROJECT: PRELIMINARY SOIL INVESTIGATION REPORT APN: 191-150-031, 032 & 033 RIVERSIDE, CALIFORNIA TITLE: SITE LOCATION MAP	DATE: APRIL 2020 PROJECT NO.: 20112-01 FIGURE NO.: Figure 1



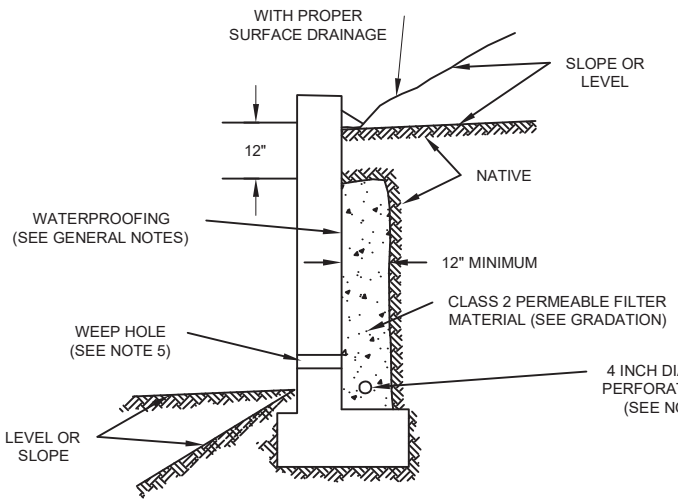
EXPLORATORY BOREHOLE LOCATION MAP

APN: 191-150-031, 032 & 033
RIVERSIDE, CALIFORNIA

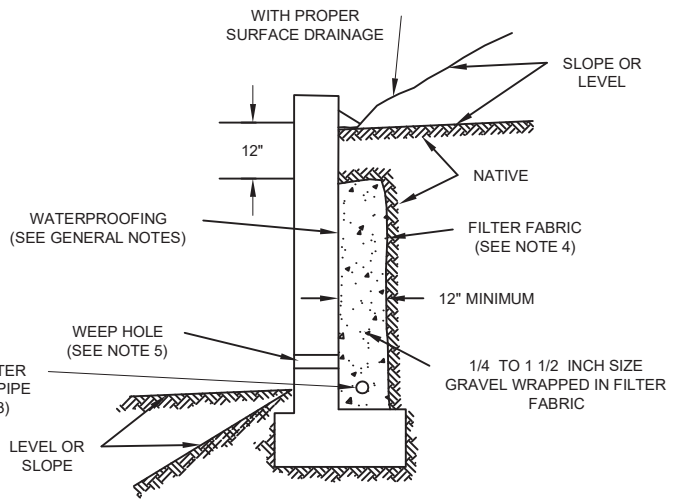
geomat	DRAWN BY: AM	DATE: APRIL 2020	PLATE 1
	SCALE: 1" = 40' (APPROXIMATE, 11"X17" SHEET)	PROJECT NO.: 20112-01	

SUBDRAIN OPTIONS AND BACKFILL WHEN NATIVE MATERIAL HAS EXPANSION INDEX ≤ 50

OPTION 1: PIPE SURROUNDED WITH CLASS 2 PERMEABLE MATERIAL



OPTION 2: GRAVEL WRAPPED IN FILTER FABRIC



Class 2 Filter Permeable Material Gradation
Per Caltrans Specifications

Sieve Size	Percent Passing
1"	100
3/4"	90-100
3/8"	40-100
No. 4	25-40
No. 8	18-33
No. 30	5-15
No. 50	0-7
No. 200	0-3

GENERAL NOTES:

*Waterproofing should be provided where moisture nuisance problem through the wall is undesireable.
*Water proofing of the walls is not under the purview of the geotechnical engineer.
*All drains should have a gradient of 1 percent minimum.
*Outlet portion of the subdrain should have a 4-inch diamater solid pipe discharged into a suitable disposal area designed by the project engineer. The subdrain pipe should be accessible for maintenance (rodding).
*Other subdrain backfill options are subject to the review by the geotechnical engineer and modification of design parameters.

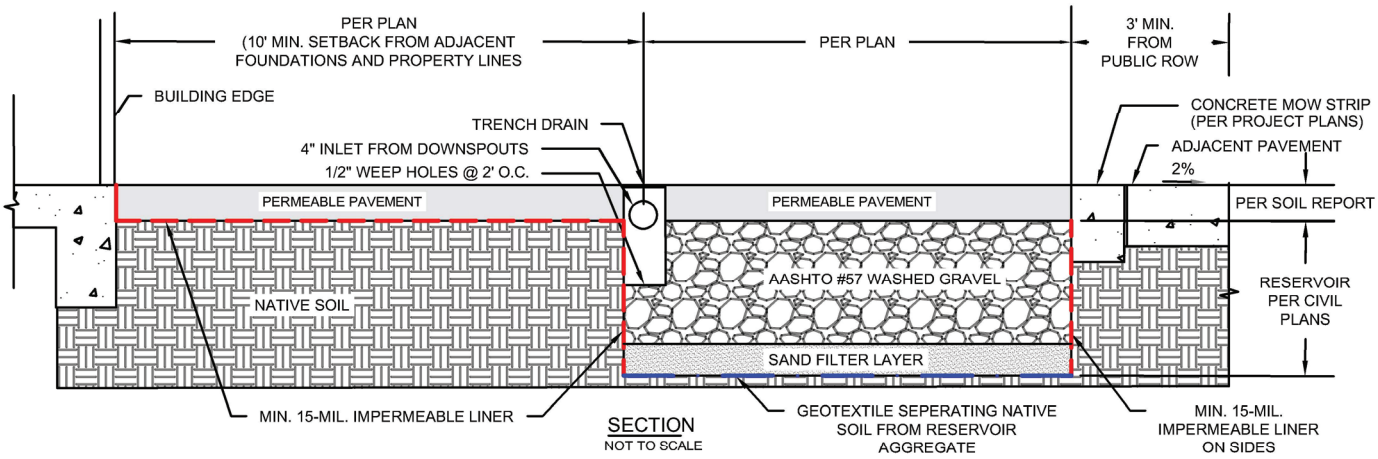
Notes:

1) Sand should have a sand equivalent of 30 or greater and may be densified by water jetting.
2) 1 Cu. ft. per ft. of 1/4 - to 1 1/2 -inch size gravel wrapped in filter fabric
3) Pipe type should be ASTM D1527 Acrylonitrile Butadiene Styrene (ABS) SDR35 or ASTM D1785 Polyvinyl Chlorise plastic (PVC), Schedule 40, Armco A2000 PVC, or approved equivalent. Pipe should be installed with perforations down. Perforations should be 3/8 -inch in diameter placed at the ends of a 120-degree arc in two rows at 3-inch on center (staggered).
4) Filter Fabric should be Mirafi 140NC or approved equivalent.
5) Weephole should be 3-inch minimum diameter and provided at 10-foot maximum intervals. if exposure is permitted, weepholes should be located 12-inches above finished grade. If exposure is not permitted, such as for a wall adjacent to a sidewalk/curb, a pipe under the sidewalk to be discharged through the curb face or equivalent should be provided. For a basement-type wall, a proper subdrain outlet system should be provided.
6) Retaining wall plans should be reviewed and approved by the geotechnical engineer.
7) Walls over six feet in height are subject to a special review by the geotechnical engineer and modifications to the above requirements.

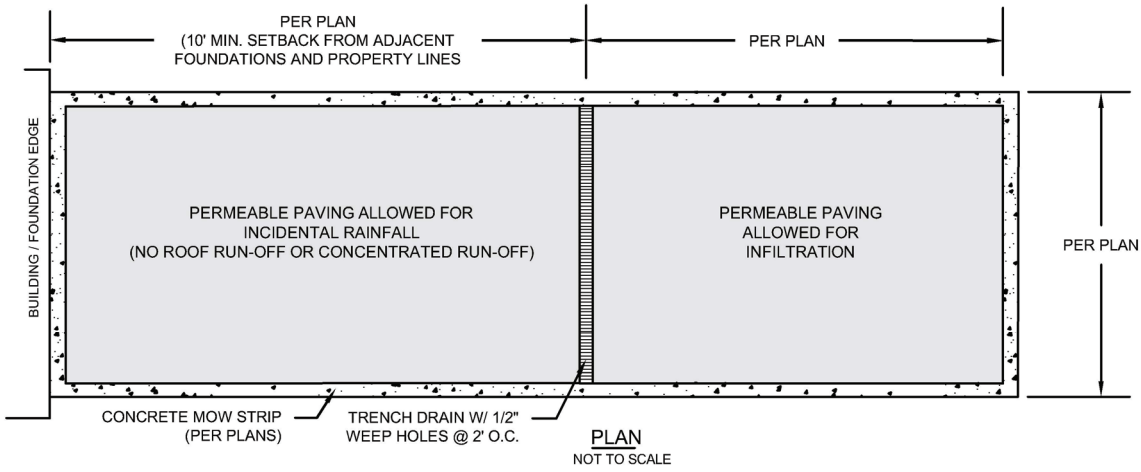
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RETAINING WALL BACKFILL AND SUBDRAIN DETAIL

PLATE 2



SECTION
NOT TO SCALE



PLAN
NOT TO SCALE

NOTES:

1. SITE SOILS SHALL HAVE ADEQUATE DRAINAGE (AT LEAST 0.5 INCHES PER HOUR).
2. INFILTRATION SHALL NOT CAUSE GEOTECHNICAL HAZARDS RELATED TO EXPANSIVE SOIL MOVEMENT, TUNNEL EROSION, OR SLOPE STABILITY.
3. IF INFILTRATION HARZARDS ARE A CONCERN, AN UNDERDRAIN SHALL BE INSTALLED TO DRAIN WATER INTO STORM DRAIN INLET OR ONSITE BMP.
4. ANY OVERFLOW SHALL BE DISCHARGED PER BUREAU OF ENGINEERING AND BUILDING & SAFETY REQUIREMENTS.
5. SLOPE IS NOT GREATER THAN 3 PERCENT.
6. FLOW DIRECTED TO PERMEABLE PAVEMENT SHALL BE DISPERSED SO AS NOT TO BE CONCENTRATED AT A SMALL AREA OF PAVEMENT.
7. PRE-FABRICATED PRODUCTS HAVE BEEN INSTALLED PER ALL APPROPRIATE MANUFACTURER'S SPECIFICATIONS. IF REQUIRED, SUB-GRADE SOIL SHALL BE COMPACTED IN ACCORDANCE WITH PRODICT INSTALLATION SPECIFICATION.

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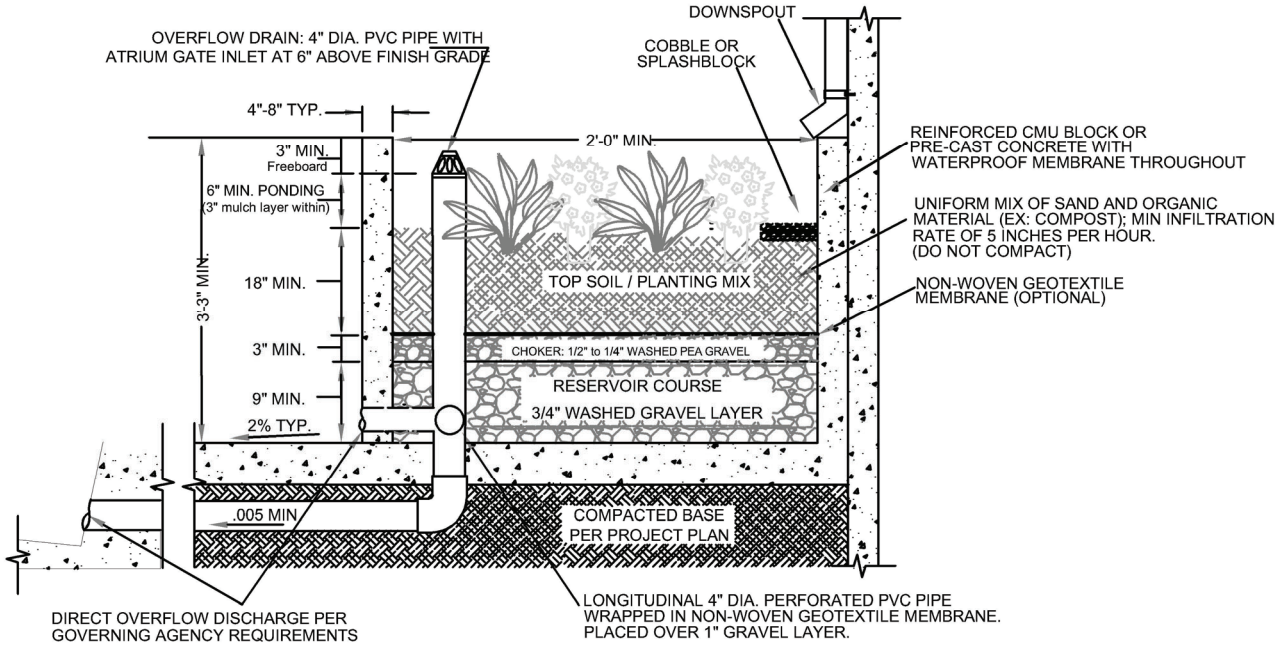
PROJECT: PRELIMINARY SOIL INVESTIGATION REPORT
APN: 191-150-031, 032 & 033
RIVERSIDE, CALIFORNIA

TITLE: TYPICAL PERMEABLE PAVEMENT DETAIL

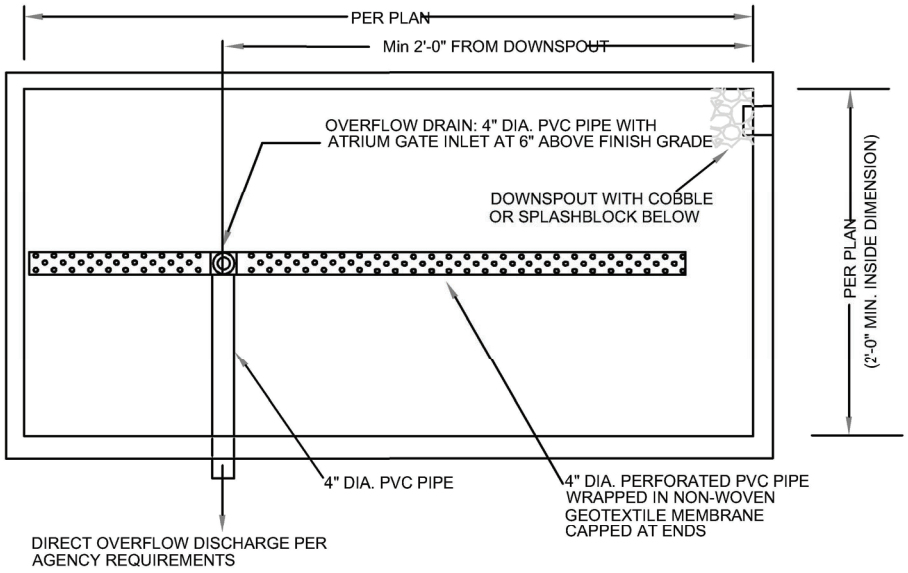
DATE: APRIL 2020

PROJECT NO.: 20112-01

FIGURE NO.: Plate 3



SECTION NOT TO SCALE



PLAN NOT TO SCALE

NOTES:

1. AT LEAST 9 INCHES SHALL BE PROVIDED BETWEEN THE PLANTING SURFACE AND THE CREST OF EACH PLANTER
2. PLANTERS SHALL NOT BE LOCATED ON UNEVEN OR SLOPED SURFACES.
3. TOP SOIL/PLANTING MIX IS AT LEAST 18" DEEP.
4. TOP SOIL CONTAINS NO MORE THAN 30% COMPOST.
5. MINIMUM GRAVEL LAYER SHALL BE 12" DEEP.
6. DIRECT OVERFLOW DISCHARGE PER AGENCY REQUIREMENTS.
7. PLANTING IS REQUIRED. CONSULT LANDSCAPE ARCHITECT FOR SPECIFIC PLANT TYPES.

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REV. NO.:	--

PROJECT: PRELIMINARY SOIL INVESTIGATION REPORT
APN: 191-150-031, 032 & 033
RIVERSIDE, CALIFORNIA

TITLE: TYPICAL STORMWATER PLANTER DETAIL

DATE: APRIL 2020

PROJECT NO.: 20112-01

FIGURE NO.: Plate 4

APPENDIX A



REFERENCES

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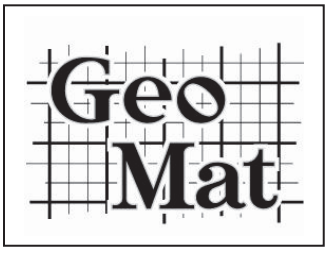
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Department of the Navy, Design Manual 7.01, Soil Mechanics, September 1986.

Department of the Navy, Design Manual 7.02, Foundation and Earth Structures, September 1986.

Yang H. Huang, Pavement Analysis and Design, 1993

APPENDIX B



SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND 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 GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: Dual symbols are used to indicate gravels or sand with 5-12% fines and soils with fines classifying as CL-ML. Symbols separated by a slash

RELATIVE DENSITY

SANDS AND GRAVELS	SPT, N
VERY LOOSE	0 - 4
LOOSE	4 -10
MEDIUM DENSE	10 - 30
DENSE	30 - 50
VERY DENSE	50+

CONSISTENCY

SILTS AND CLAYS	SPT, N	UNCONFINED COMPRESSIVE STRENGTH, tsf
VERY SOFT	0 - 2	0 - 0.25
SOFT	2 - 4	0.25 - 0.50
MEDIUM FIRM	4 - 8	0.50 - 1.00
FIRM	8 - 15	1.00 - 2.00
VERY FIRM	15 - 30	2.00 - 4.00
HARD	30+	>4.00

MOISTURE CONDITION

DESCRIPTION	CRITERIA
DRY	Absence of moisture, dusty, dry to the touch
MOIST	Damp but no visible water
WET	Visible free water, usually soil is below water table

CONSTITUENT DESCRIPTIONS

DESCRIPTION	CRITERIA	DESCRIPTION	CRITERIA
TRACE	Less than 5%	SOME	30% to 45%
FEW	5% to 10%	MOSTLY	50% to 100%
LITTLE	15% to 25%		

Sampler and Symbol Descriptions

B — Bulk "grab" sample taken from the auger cuttings or excavated soil

S — 1.4" I.D./2" O.D. Standard Penetration Test (ASTM D1586) sampler (SPT)

R — 2.5" I.D./3" O.D. Modified California Ring Sampler (Ring)

D — 2.5" I.D./3" O.D. Dames and Moore Manual Ring Sampler

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KEY TO BORING LOGS

APPENDIX B

PROJECT: **APN: 191-150-031, 032 & 033 Riverside, California**

Log of Boring B-1

PAGE 1 of 1

Project No.	**20068-01**	Boring Location:	**See Plate 1**	Logged by:	**AM**
Drill Company/Rig	**Geoboden/CME-75**	Date Started:	**4/3/2020**	Notes:	Groundwater @ 25' bgs
Drilling Method:	**Hollow Stem Auger**	Date Finished:	**4/3/2020**		
Hammer Weight/Drop:	**140 lbs./30-inches**	Hammer Type:	**Automatic**		

Sampler(s): California Ring (R), Standard Penetration Test (S), Bulk "Grab" Sample (B)

DEPTH (FT)	SAMPLES Type	Sample	Blows / 6"	SPT "N" Value	Graphic Log	Classification (USCS)	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	Fines (%)	Liquid Limit	Plastic Limit	Plast. Index
							LABORATORY TEST DATA						
5	B					SC	**CLAYEY SAND/SANDY LEAN CLAY** reddish-brown clayey sand and sandy lean clay very moist at surface cohesive						
	R		22 38 27	42			dense red-brown clayey sand becoming more sandy with depth less cohesive	15	109	43			
10	S		21 50/3"	>50			**GRANITIC BEDROCK** light gray granitic bedrock weathered, slightly moist drills like well-graded sand with silt	6		7			
15	S		32 50/5"	>50			very dense slightly moist						
20	S		50/5"	>50			very dense slightly moist						
25						▽	GROUNDWATER AT 25 FEET BGS						
	S		50/5"	>50			very dense very moist to wet						
30	S		50/4"	>50			very dense very moist to wet	16		10			
35	S		50/3"	>50			very dense very moist to wet						
40	S		50/4"	>50			very dense very moist to wet						
45	S		50/5"	>50			very dense very moist to wet						
50	S		50/3"	>50			very dense very moist to wet	17		7			
							TD = 50'						

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This log is part of the report prepared by GeoMat for this project and should be read together with the report. This summary applies only at the location of the exploration and at the time of drilling or excavation. Subsurface conditions may differ at other locations and may change at this location with tiume. Data presented are a simplification of actual conditions encountered.

PROJECT NO. 20068-01

APPENDIX B

PROJECT: **APN: 191-150-031, 032 & 033**
Riverside, California

Log of Boring B-2

Project No.	**20068-01**	Boring Location:	**See Plate 1**
Drill Company/Rig	**Geoboden/CME-75**	Date Started:	**4/3/2020**
Drilling Method:	**Hollow Stem Auger**	Date Finished:	**4/3/2020**
Hammer Weight/Drop:	**140 lbs./30-inches**	Hammer Type:	**Automatic**

Logged by: **AM**
Notes: Groundwater @ 15' bgs

Sampler(s): California Ring (R), Standard Penetration Test (S), Bulk "Grab" Sample (B)

LABORATORY TEST DATA

DEPTH (FT)	SAMPLES Type	Sample	Blows / 6"	SPT "N" Value	Graphic Log	Classification (USCS)	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	Fines (%)	Liquid Limit	Plastic Limit	Plast. Index
0	B					SC	**CLAYEY SAND/SANDY LEAN CLAY** reddish-brown clayey sand and sandy lean clay very moist at surface						
	R		9 15 25	26			very cohesive very firm clay, tree roots encountered	22	103				
5	R		6 8 15	15			**GRANITIC BEDROCK** light gray decomposed granitic bedrock weathered slightly moist						
10	S		18 38 46	>50			very dense granitic bedrock moist drills like well-graded sand with silt						
15						▽	GROUNDWATER AT 15 FEET BGS						
	S		37 50/3"	>50			very dense slightly moist TD = 15'						
20													
25													
30													
35													
40													
45													
50													

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This log is part of the report prepared by GeoMat for this project and should be read together with the report. This summary applies only at the location of the exploration and at the time of drilling or excavation. Subsurface conditions may differ at other locations and may change at this location with tiume. Data presented are a simplification of actual conditions encountered.

PROJECT NO. 20068-01

APPENDIX B

PROJECT: **APN: 191-150-031, 032 & 033 Riverside, California**

Log of Boring B-3

Project No.	**20068-01**	Boring Location:	**See Plate 1**
Drill Company/Rig	**Geoboden/CME-75**	Date Started:	**4/3/2020**
Drilling Method:	**Hollow Stem Auger**	Date Finished:	**4/3/2020**
Hammer Weight/Drop:	**140 lbs./30-inches**	Hammer Type:	**Automatic**

Logged by: **AM**

Notes: Groundwater @ 15' bgs

Sampler(s): California Ring (R), Standard Penetration Test (S), Bulk "Grab" Sample (B)

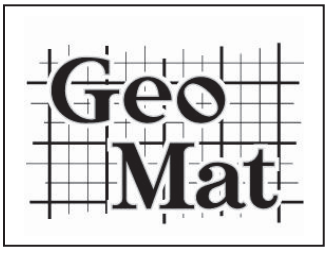
DEPTH (FT)	SAMPLES Type	Sample	Blows / 6"	SPT "N" Value	Graphic Log	Classification (USCS)	MATERIAL DESCRIPTION	LABORATORY TEST DATA: Moisture Content (%)	Dry Density (pcf)	Fines (%)	Liquid Limit	Plastic Limit	Plast. Index
0	B					SC	**CLAYEY SAND/SANDY LEAN CLAY** reddish-brown clayey sand and sandy lean clay very moist at surface						
	R		13 30 34	42			very cohesive, hard sandy lean clay	15	118				
5	R		12 21 25	30			light reddish brown to olive brown clayey sand medium dense moist, very cohesive grading into weathered granitics						
10	S		13 28 50/3"	>50			**GRANITIC BEDROCK** light gray decomposed granitic bedrock weathered, slightly moist less cohesive						
						▽	GROUNDWATER AT 15 FEET BGS						
15	S		25 50/5"	>50			very dense TD = 15'						
20													
25													
30													
35													
40													
45													
50													

This log is part of the report prepared by GeoMat for this project and should be read together with the report. This summary applies only at the location of the exploration and at the time of drilling or excavation. Subsurface conditions may differ at other locations and may change at this location with tiume. Data presented are a simplification of actual conditions encountered.

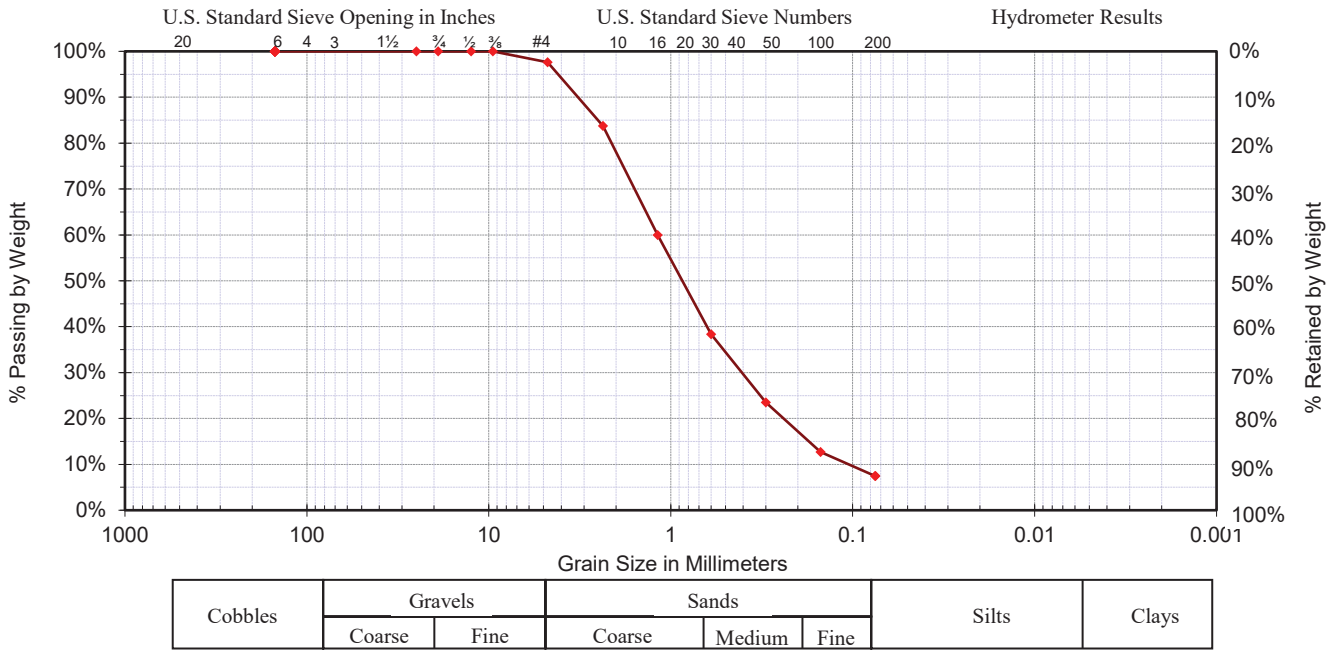
PROJECT NO. 20068-01

APPENDIX B

APPENDIX C



LABORATORY TEST RESULTS



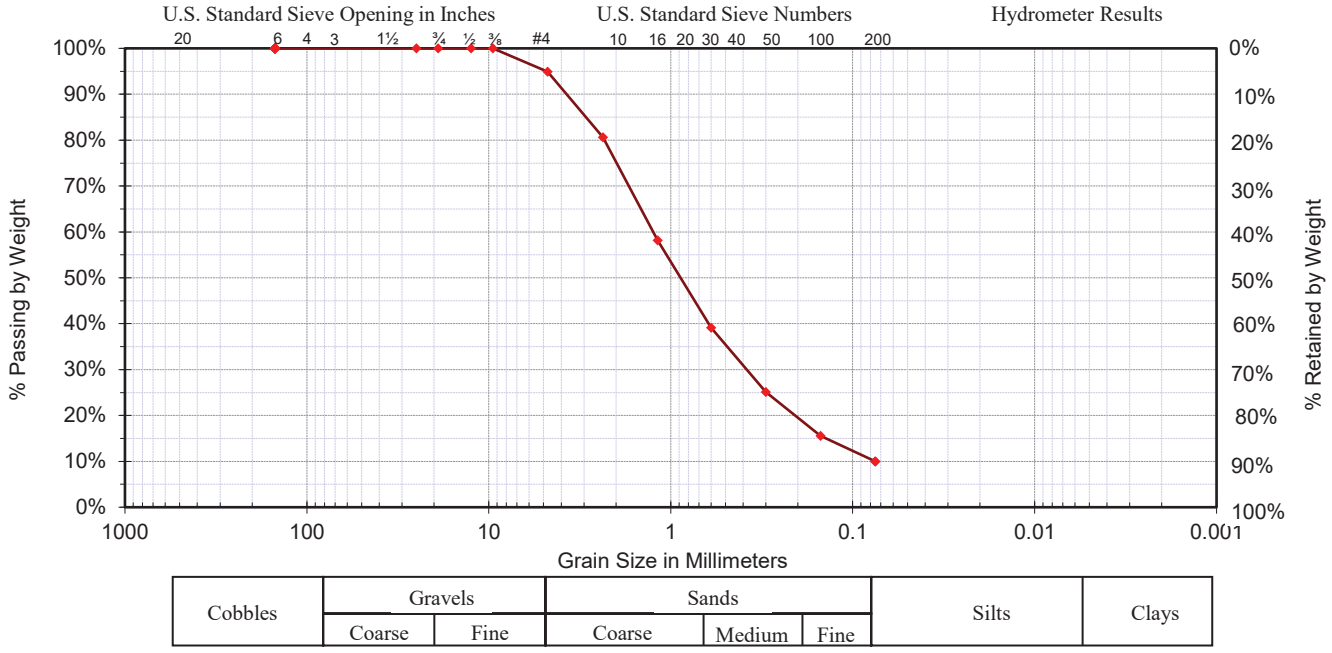
Date :	04/16/20	D_{10} =	0.11	**Classification**	% Gravel
Sample #:		D_{30} =	0.43	SW-SM, Well-graded Sand with Silt	2.41%
Sample ID:	B-1 @ 10'	D_{60} =	1.18		% Sand
Source:	SPT	C_C =	1.41	**Specifications**	90.16%
Project:	APN: 191-150-031, 032, 033	$C_{U=}$	10.57	custom specs 1	% Silt & Clay
Location:	SEC of Arlington Avenue and Monroe Street, Rivel	Liquid Limit=	n/a		7.43%
Boring #:	B-1	Plastic Limit=	n/a	Fineness Modulus	Sample Moisture
Depth:	10'	Plasticity Index=	n/a	2.84	**6.4%**

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%	100.0%		
7/8"	22.40		100.0%		
3/4"	19.00	100.0%	100.0%		
5/8"	16.00		100.0%		
1/2"	12.50	100.0%	100.0%		
3/8"	9.50	100.0%	100.0%		
1/4"	6.30		98.4%		
#4	4.75	97.6%	97.6%		

Fines Section		Actual Cumulative	Interpolated Cumulative		
Sieve Size		Percent	Percent	Specs	Specs
US	Metric	Passing	Passing	Max	Min
#4	4.750	97.6%	97.6%		
#8	2.360	83.7%	83.7%		
#10	2.000		76.5%		
#16	1.180	60.0%	60.0%		
#20	0.850		47.7%		
#30	0.600	38.3%	38.3%		
#40	0.425		29.7%		
#50	0.300	23.5%	23.5%		
#60	0.250		19.9%		
#80	0.180		14.8%		
#100	0.150	12.7%	12.7%		
#140	0.106		9.6%		
#170	0.090		8.5%		
#200	0.075	7.4%	7.4%		
#270	0.053				

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LABORATORY TEST RESULTS



Date : 04/16/20
Sample #:
Sample ID: B-1 @ 30'
Source: SPT
Project: APN: 191-150-031, 032, 033
Location: SEC of Arlington Avenue and Monroe Street, Rivers
Boring #: B-1
Depth: 30'

D_{10} = 0.08
D_{30} = 0.40
D_{60} = 1.28
C_C = 1.71
$C_{U=}$ 16.96
Liquid Limit= n/a
Plastic Limit= n/a
Plasticity Index= n/a

Classification
SW-SM, Well-graded Sand with Silt

Specifications
custom specs 1

Fineness Modulus
2.87

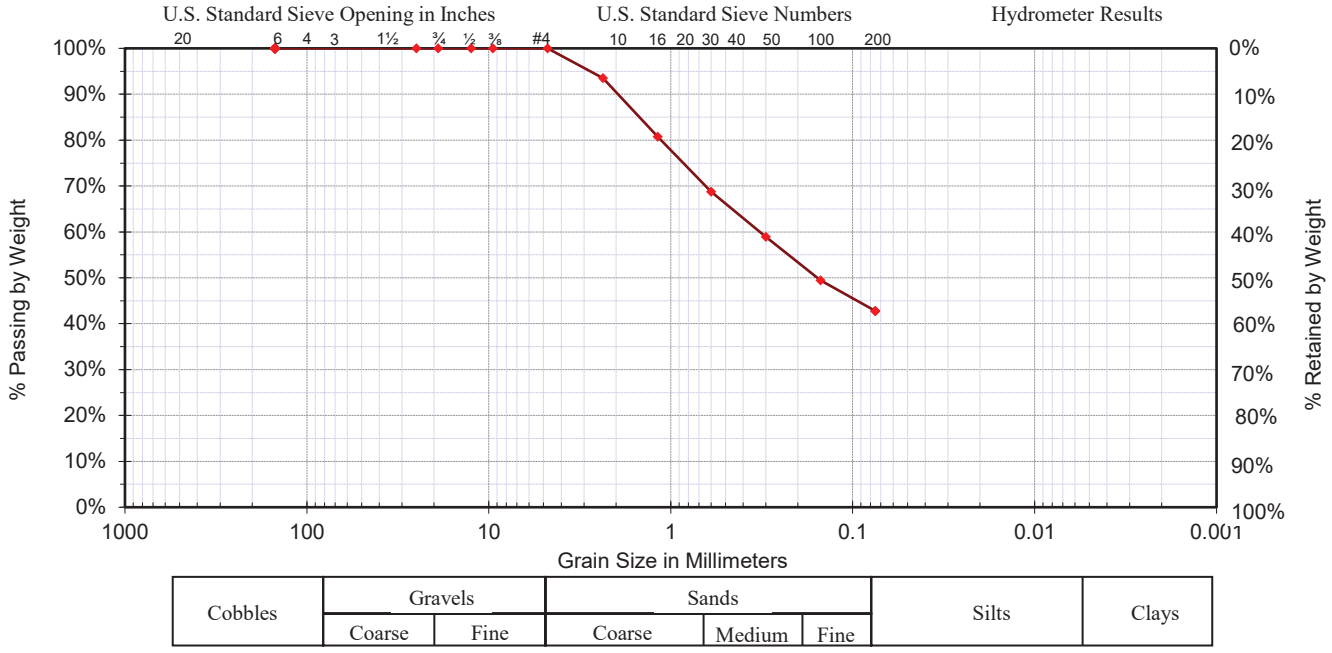
% Gravel
5.09%
% Sand
84.92%
% Silt & Clay
9.98%
Sample Moisture
15.7%

Coarse Section Sieve Size US	Metric	Actual Cumulative Percent Passing	Interpolated Cumulative 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%	100.0%		
7/8"	22.40		100.0%		
3/4"	19.00	100.0%	100.0%		
5/8"	16.00		100.0%		
1/2"	12.50	100.0%	100.0%		
3/8"	9.50	100.0%	100.0%		
1/4"	6.30		96.6%		
#4	4.75	94.9%	94.9%		

Fines Section Sieve Size US	Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
#4	4.750	94.9%	94.9%		
#8	2.360	80.6%	80.6%		
#10	2.000		73.8%		
#16	1.180	58.2%	58.2%		
#20	0.850		47.3%		
#30	0.600	39.1%	39.1%		
#40	0.425		31.0%		
#50	0.300	25.1%	25.1%		
#60	0.250		21.9%		
#80	0.180		17.5%		
#100	0.150	15.5%	15.5%		
#140	0.106		12.3%		
#170	0.090		11.1%		
#200	0.075	10.0%	10.0%		
#270	0.053				

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LABORATORY TEST RESULTS



Date : 04/16/20
Sample #:
Sample ID: B-1 @ 5'
Source: Ring
Project: APN: 191-150-031, 032, 033
Location: SEC of Arlington Avenue and Monroe Street, Rivel
Boring #: B-1
Depth: 5'

D_{10} = 0.02
D_{30} = 0.05
D_{60} = 0.33
C_C = 0.47
$C_{U=}$ 19.01
Liquid Limit= n/a
Plastic Limit= n/a
Plasticity Index= n/a

Classification
SC, Clayey Sand

Specifications
custom specs 1

Fineness Modulus
1.49

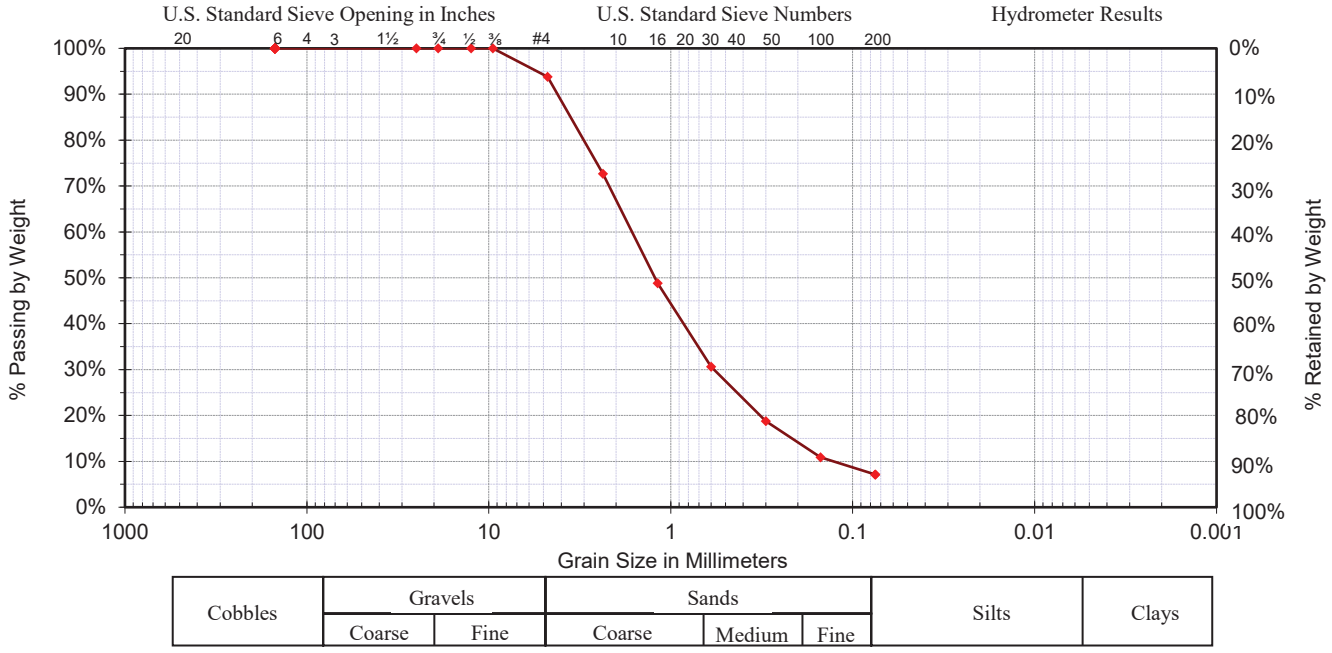
% Gravel
0.00%
% Sand
57.23%
% Silt & Clay
42.77%
Sample Moisture
14.5%

Coarse Section Sieve Size US	Metric	Actual Cumulative Percent Passing	Interpolated Cumulative 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%	100.0%		
7/8"	22.40		100.0%		
3/4"	19.00	100.0%	100.0%		
5/8"	16.00		100.0%		
1/2"	12.50	100.0%	100.0%		
3/8"	9.50	100.0%	100.0%		
1/4"	6.30		100.0%		
#4	4.75	100.0%	100.0%		

Fines Section Sieve Size US	Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
#4	4.750	100.0%	100.0%		
#8	2.360	93.5%	93.5%		
#10	2.000		89.6%		
#16	1.180	80.8%	80.8%		
#20	0.850		74.0%		
#30	0.600	68.8%	68.8%		
#40	0.425		63.0%		
#50	0.300	58.9%	58.9%		
#60	0.250		55.7%		
#80	0.180		51.3%		
#100	0.150	49.4%	49.4%		
#140	0.106		45.5%		
#170	0.090		44.1%		
#200	0.075	42.8%	42.8%		
#270	0.053				

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LABORATORY TEST RESULTS



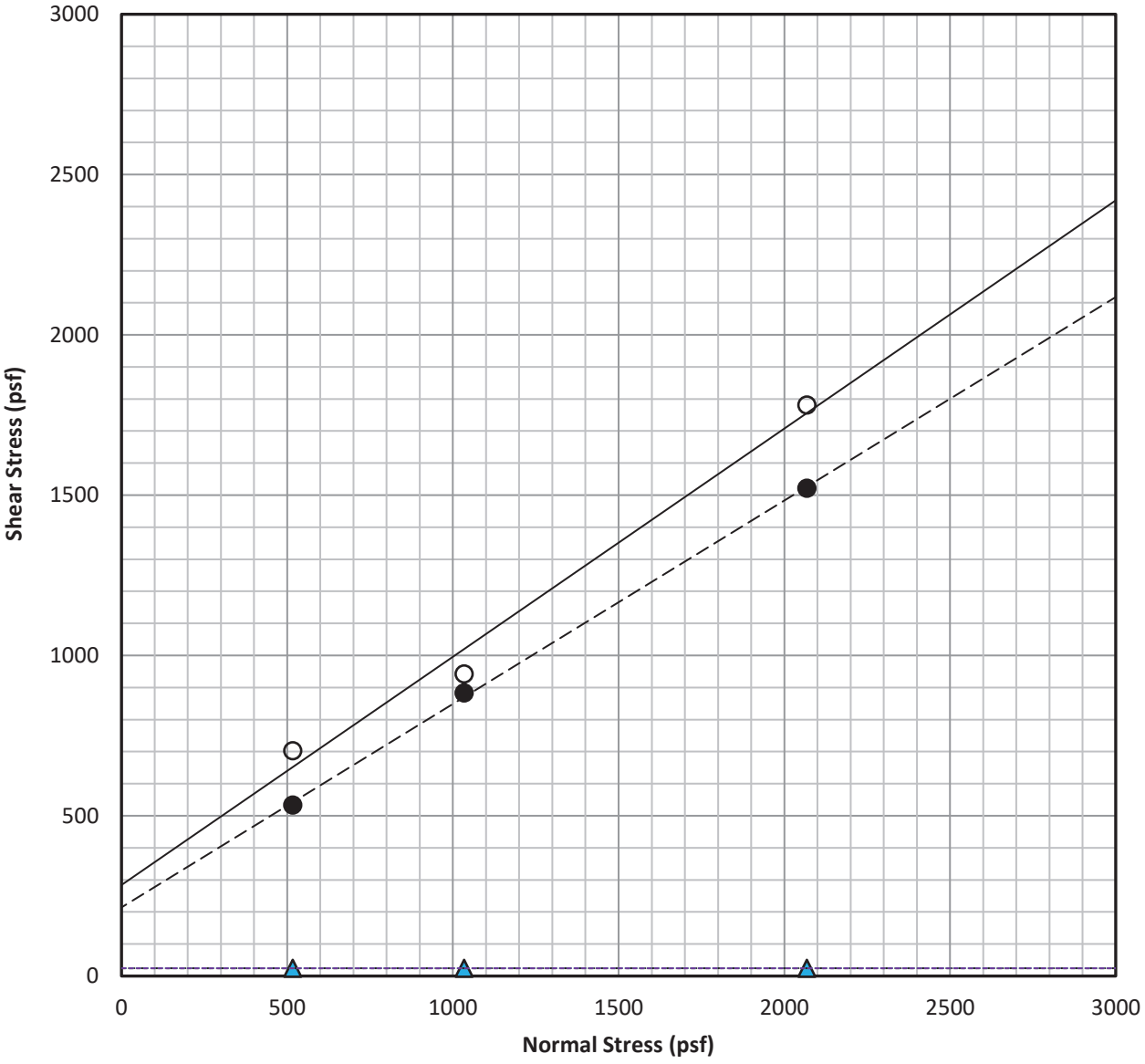
Date :	04/16/20	D_{10} =	0.13	**Classification**	% Gravel
Sample #:		D_{30} =	0.58	SW-SM, Well-graded Sand with Silt	6.22%
Sample ID:	B-1 @ 50'	D_{60} =	1.73		% Sand
Source:	SPT	C_C =	1.48	**Specifications**	86.66%
Project:	APN: 191-150-031, 032, 033	C_U =	13.06	custom specs 1	% Silt & Clay
Location:	SEC of Arlington Avenue and Monroe Street, Rivel	Liquid Limit=	n/a		7.12%
Boring #:	B-1	Plastic Limit=	n/a	Fineness Modulus	Sample Moisture
Depth:	50'	Plasticity Index=	n/a	3.25	**17.2%**

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%	100.0%		
7/8"	22.40		100.0%		
3/4"	19.00	100.0%	100.0%		
5/8"	16.00		100.0%		
1/2"	12.50	100.0%	100.0%		
3/8"	9.50	100.0%	100.0%		
1/4"	6.30		95.8%		
#4	4.75	93.8%	93.8%		

Fines Section		Actual Cumulative	Interpolated Cumulative		
Sieve Size		Percent	Percent	Specs	Specs
US	Metric	Passing	Passing	Max	Min
#4	4.750	93.8%	93.8%		
#8	2.360	72.6%	72.6%		
#10	2.000		65.4%		
#16	1.180	48.8%	48.8%		
#20	0.850		38.5%		
#30	0.600	30.6%	30.6%		
#40	0.425		23.7%		
#50	0.300	18.8%	18.8%		
#60	0.250		16.1%		
#80	0.180		12.4%		
#100	0.150	10.9%	10.9%		
#140	0.106		8.7%		
#170	0.090		7.9%		
#200	0.075	7.1%	7.1%		
#270	0.053				

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DIRECT SHEAR TEST RESULTS



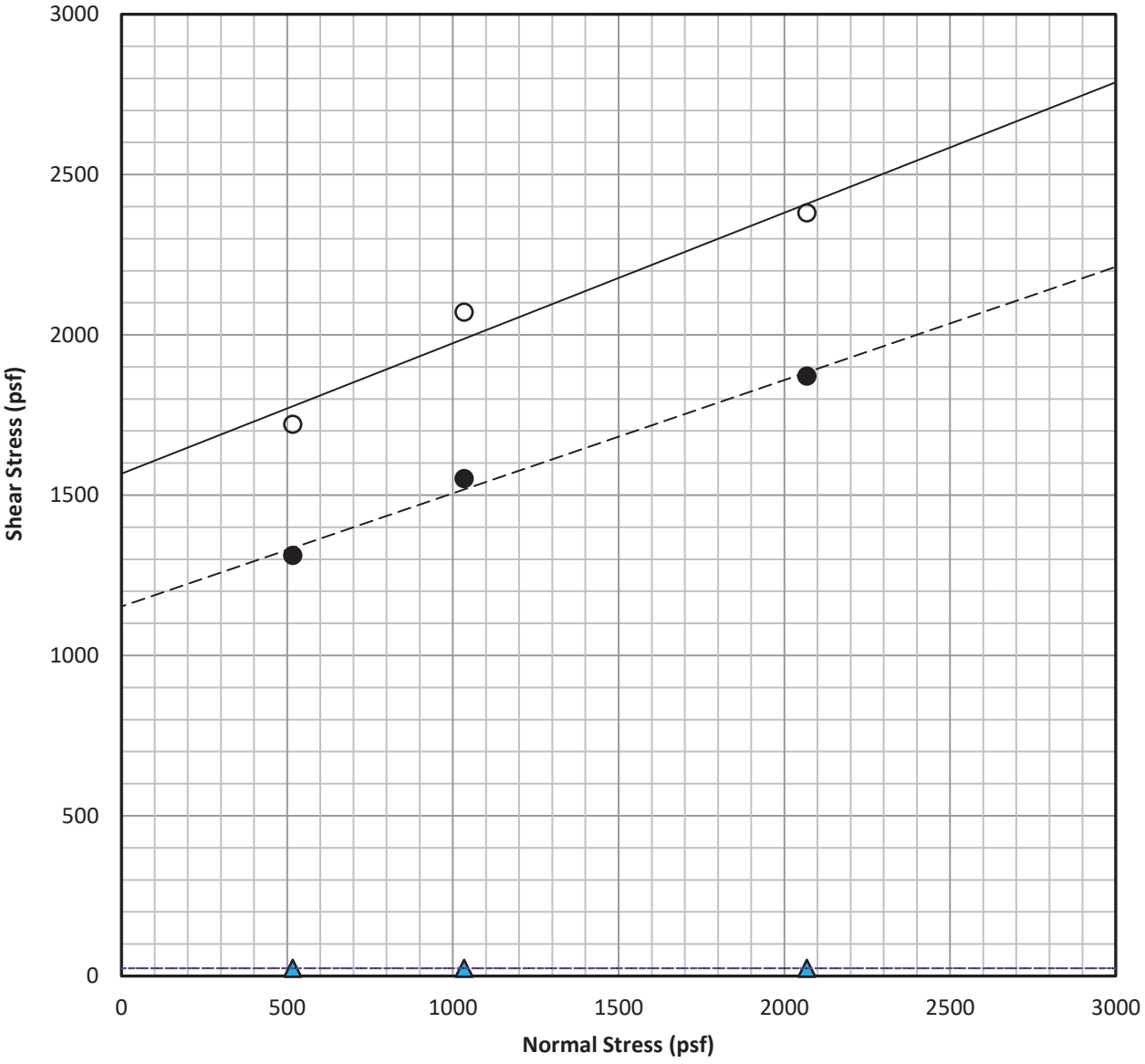
Sample	Symbol	Description	Soil Type [USCS]	Shear Strength	Friction Angle, ϕ [degrees]	Cohesion, c [psf]
B-1 @ 5'	—○—	Clayey Sand	SC	Peak	35.4	284
B-1 @ 5'	— ● —	Clayey Sand	SC	Ultimate	32.4	214
B-1 @ 5'	- - ▲ - -	Clayey Sand	SC	*Residual	N/A	N/A

Sample Moisture [%]	Saturated Moisture [%]	Dry Unit Weight [pcf]
13.1	24.1	109.0

ASTM D-3080

*Residual results were determined from the lowest re-shear values obtained after 5 re-shears

DIRECT SHEAR TEST RESULTS



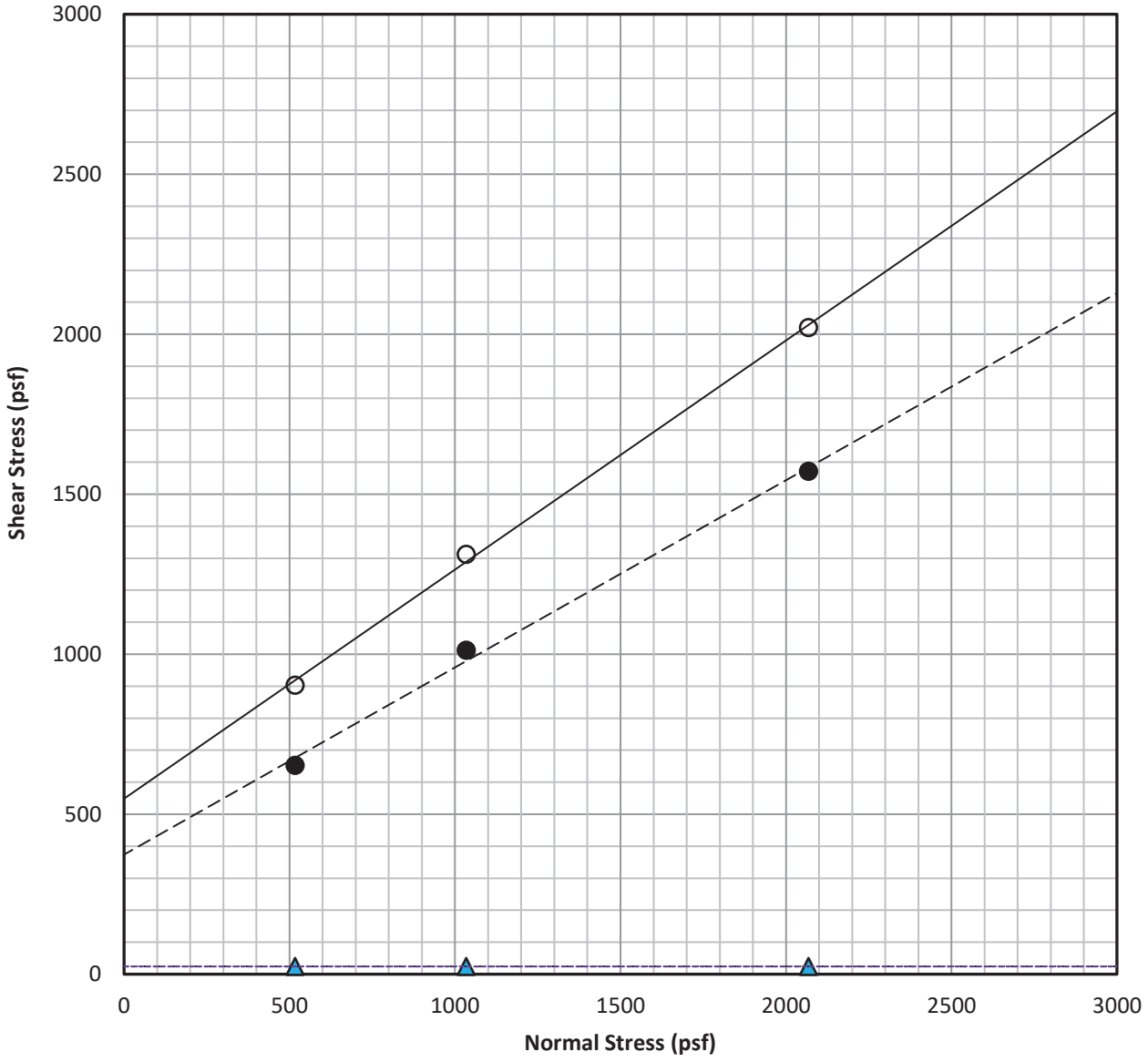
Sample	Symbol	Description	Soil Type [USCS]	Shear Strength	Friction Angle, ϕ [degrees]	Cohesion, c [psf]
B-2 @ 3'	—○—	Sandy Lean Clay	CL	Peak	22.1	1567
B-2 @ 3'	— ● —	Sandy Lean Clay	CL	Ultimate	19.5	1153
B-2 @ 3'	- - △ - -	Sandy Lean Clay	CL	*Residual	N/A	N/A

Sample Moisture [%]	Saturated Moisture [%]	Dry Unit Weight [pcf]
21.8	30.5	102.5

ASTM D-3080

*Residual results were determined from the lowest re-shear values obtained after 5 re-shears

DIRECT SHEAR TEST RESULTS



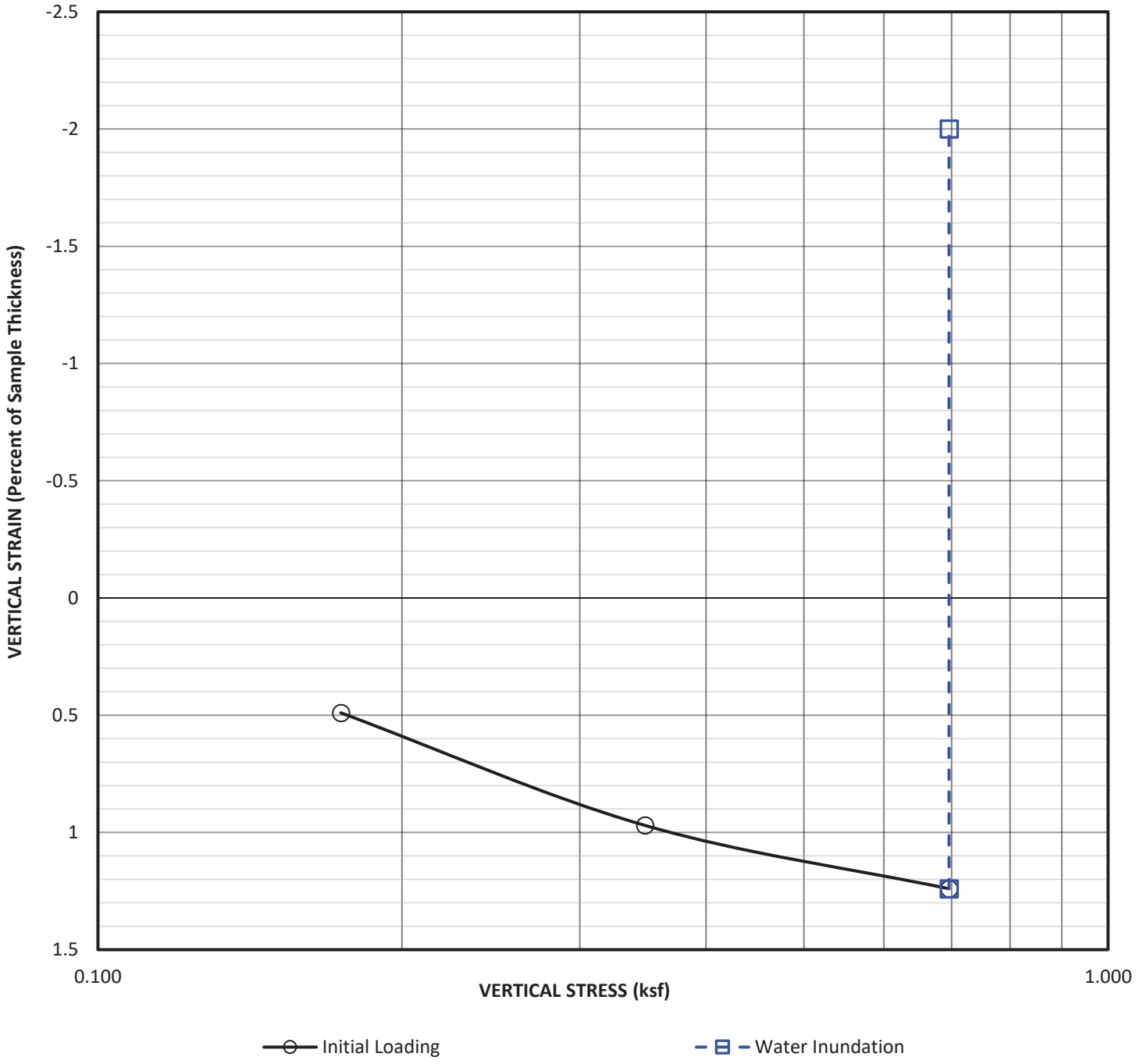
Sample	Symbol	Description	Soil Type [USCS]	Shear Strength	Friction Angle, ϕ [degrees]	Cohesion, c [psf]
B-3 @ 3'	—○—	Clayey Sand	SC	Peak	35.6	549
B-3 @ 3'	— ● —	Clayey Sand	SC	Ultimate	30.3	374
B-3 @ 3'	- - △ - -	Clayey Sand	SC	*Residual	N/A	N/A

Sample Moisture [%]	Saturated Moisture [%]	Dry Unit Weight [pcf]
15.2	18.9	117.7

ASTM D-3080

*Residual results were determined from the lowest re-shear values obtained after 5 re-shears

COLLAPSE TEST REPORT



Sampler Type:	California Ring Sampler			Condition:	Before Test			After Test			
Diameter(in):	2.41	Height(in):	1.0	Water Content:	w_0	12.5	%	w_f	20.0	%	
Overburden Pressure, P_0	0.3	tsf		Void Ratio:	e_0	0.432		e_f	0.461		
Preconsol. Pressure, P_c	N/A	ksf		Saturation:	S_0	75.4	%	S_f	113.1	%	
LL: --	PL: --	PI: --		Dry Density:	γ_d	113.2	pcf	γ_d	111.1	pcf	
% Collapse:	-3.24 %	"No Collapse"		Specific Gravity, G_S		2.6		(Assumed)			
Sample Location:	B1 @ 5'			Hydro-Collapse Test				geomat			
Soil Classification:	Clayey Sand										

EXPANSION INDEX TEST

(ASTM D4829)

BORING NUMBER AND SAMPLE DEPTH:	B-1 @ 0-5'
SOIL TYPE (USCS):	SC
CONFINING PRESSURE (psf):	144
INITIAL MOISTURE CONTENT (%):	9.1
FINAL MOISTURE CONTENT (%):	19.1
DRY DENSITY (pcf):	105.7
EXPANSION INDEX:	15
EXPANSION POTENTIAL:	Very Low
DATE TESTED:	4/21/2020
TESTED BY:	HMN

GeoMat Testing Laboratories, Inc.

Soil Engineering, Environmental Engineering, Materials Testing, Geology

SOLUBLE SULFATE AND CHLORIDE TEST RESULTS

Project Name	APN: 191-150-031, 032 & 033, Riverside, California	**Test Date**	04/22/2020
Project No.	20112-01	**Date Sampled**	04/16/2020
Project Location	APN: 191-150-031, 032 & 033, Riverside, California	**Sampled By**	AN
Location in Structure	B-1 @ 0-5'	**Sample Type**	Bulk
Sampled Classification	SC	**Tested By**	HMN

TESTING INFORMATION

Sample weight before drying	
Sample weight after drying	
Sample Weight Passing No. 10 Sieve	100.0 g
Moisture	

Location	Mixing Ratio	Dilution Factor	Sulfate Reading (ppm)	Sulfate Content (ppm)	Sulfate Content (%)
B-1	3	1	55	165	0.0165
			Average		

Chloride Reading (ppm)	Chloride Content (ppm)	Chloride Content (%)
Average		

pH	
Average	

ACI 318-19 Table 19.3.2.1 - Requirements for Concrete by Exposure Class

Exposure Class		Water-Soluble Sulfate (%)	Maximum *w/cm*	Minimum *f'c* (psi)	Cementitous Material (Types)			Calcium Chloride Admixture
					ASTM C150-	ASTM C595	ASTM C1157	
S0		<0.10	N/A	2500	No Type Restriction	No Type Restriction	No Type Restriction	No Restriction
S1		0.10 to 0.20	0.50	4000	II	Type IP, IS, or IT with (MS) Designation	MS	No Restriction
S2		0.20 to 2.00	0.45	4500	V	Type IP, IS, or IT with (HS) Designation	HS	Not Permitted
S3	Option 1	>2.00	0.45	4500	V + Pozzolan or Slag Cement	Type IP, IS, or IT with (HS) Designation + Pozzolan or Slag Cement	HS + Pozzolan or Slag Cement	Not Permitted
	Option 2	>2.00	0.40	5000	V	Types with (HS) designation	HS	Not Permitted

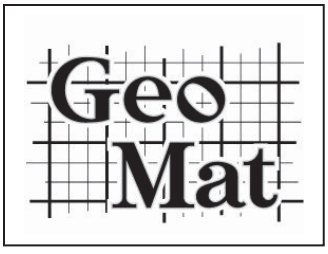
Exposure Class	Maximum *w/cm*	Minimum *f'c* (psi)	Maximum Water-Soluble Chloride ion (Cl^-) Content in Concrete, Percent by Wight of Cement		Additional Provisions
			Nonprestressed Concrete	Prestressed Concrete	
C0	N/A	2500	1.00	0.06	None
C1	N/A	2500	0.30	0.06	None
C2	0.40	5000	0.15	0.06	Concrete Cover

Caltrans classifies a site as corrosive to structural concrete as an area where soil and/or water contains >500pp chloride, >2000ppm sulfate, or has a pH <5.5. A minimum resistivity of less than 1000 ohm-cm indicates the potential for corrosive environment requiring testing for the above criteria.

The information in this form is not intended for corrosion engineering design. If corrosion is critical, a corrosion specialist should be contacted to provide further recommendations.

9980 Indiana Avenue ● Suite 14 ● Riverside ● California ● 92503 ● Phone (951) 688-5400 ● Fax (951) 688-5200
www.geomatlabs.com, contact: e-mail: info@geomatlabs.com

APPENDIX D



OSHPD

Latitude, Longitude: 33.945495, -117.444606



Date	4/23/2020, 10:54:52 AM
Design Code Reference Document	ASCE7-16
Risk Category	II
Site Class	C - Very Dense Soil and Soft Rock

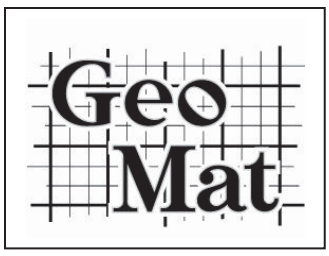
Type	Value	Description
S_S	1.5	MCE_R ground motion. (for 0.2 second period)
S_1	0.566	MCE_R ground motion. (for 1.0s period)
S_{MS}	1.8	Site-modified spectral acceleration value
S_{M1}	0.812	Site-modified spectral acceleration value
S_{DS}	1.2	Numeric seismic design value at 0.2 second SA
S_{D1}	0.541	Numeric seismic design value at 1.0 second SA

Type	Value	Description
SDC	D	Seismic design category
F_a	1.2	Site amplification factor at 0.2 second
F_v	1.434	Site amplification factor at 1.0 second
PGA	0.5	MCE_G peak ground acceleration
F_{PGA}	1.2	Site amplification factor at PGA
PGA_M	0.6	Site modified peak ground acceleration
T_L	8	Long-period transition period in seconds
SsRT	1.556	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	1.644	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	1.5	Factored deterministic acceleration value. (0.2 second)
S1RT	0.566	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.613	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S1D	0.6	Factored deterministic acceleration value. (1.0 second)
PGAd	0.5	Factored deterministic acceleration value. (Peak Ground Acceleration)
C_{RS}	0.946	Mapped value of the risk coefficient at short periods
C_{R1}	0.923	Mapped value of the risk coefficient at a period of 1 s

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APPENDIX E



LIQUEFACTION EVALUATION AND ANALYSIS

Liquefaction analysis in this spreadsheet is conducted in accordance with the requirements of Special Publication 117A (CDMG, 2008), and currently accepted practice (SCEC, 1997).
The liquefaction potential is evaluated using the empirical method described in "Soil Liquefaction During Earthquakes" I.M. Idriss & R.W. Boulanger, EERI MNO-12, 2008
Dynamic unsaturated settlement is estimated per the "Procedures to Evaluate Earthquake-Induced Settlements in Dry Sandy Soils," by Pradel, JGGE, Vol. 124, No.4, ASCE, (April 1998)

Project Name	SEC Arlington Ave and Monroe Street
Project Location	APN: 191-150-031, 032 & 033, Riverside, CA
Project Number	20112-01
Boring No.	B-1
Date Drilled	4/16/2020

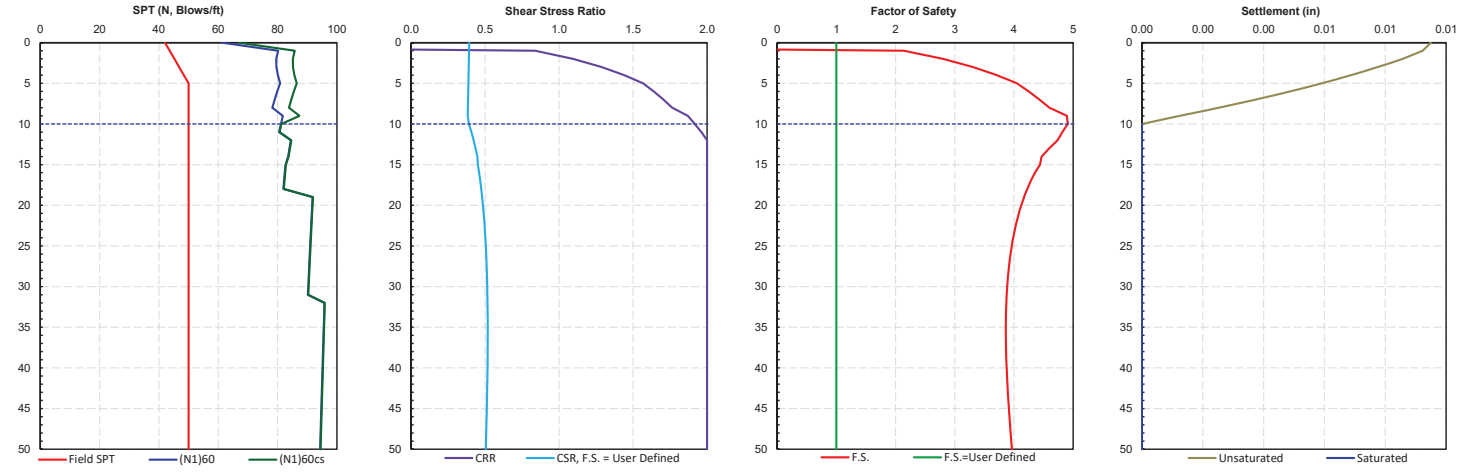
Design Earthquake Magnitude	7.3	
MCEG Design Acceleration (PGAm)	0.6	(g)
Historic High Depth to Groundwater	10	(ft)
Depth to Groundwater at Time of Drilling	15	(ft)
Borehole Diameter	8	(in)
Total Depth of Borehole	50	(ft)
Total Unit Weight of Soil (Above GW)	120	(pcf)
Total Unit Weight of Soil (Below GW)	130	(pcf)
Energy Correction (Hammer Energy Ratio)	1.3	
User Defined Factor of Safety	1	

DEPTH (ft)	LAYER (ft)	USCS	SPT	FINES	LIQ?	SETTLEMENT DRY (in)	SETTLEMENT LIQ (in)
0	(0-5)	SC	42	43	Liquefiable	0.00	0.00
5	(5-10)	SC	50	43	Liquefiable	0.01	0.00
10	(10-15)	SWSM	50	7	Liquefiable	0.00	0.00
15	(15-20)	SWSM	50	7	Liquefiable	0.00	0.00
20	(20-25)	SWSM	50	7	Liquefiable	0.00	0.00
25	(25-30)	SWSM	50	7	Liquefiable	0.00	0.00
30	(30-35)	SWSM	50	7	Liquefiable	0.00	0.00
35	(35-40)	SWSM	50	7	Liquefiable	0.00	0.00
40	(40-45)	SWSM	50	7	Liquefiable	0.00	0.00
45	(45-50)	SWSM	50	7	Liquefiable	0.00	0.00
50	(50-51)	SWSM	50	7	Liquefiable	0.00	0.00
						0.01	0.00

TOTAL SETTLEMENT = 0.01 (in)

Notes:
(1) Energy Correction for N_{90} of automatic hammer to standard N_{60}
(2) Borehole Diameter Correction (Skempton, 1986)
(3) Correction of split-spoon sampler with room for liners, but liners are absent (Seed, et al., 1984, 2001)
(4) Overburden Correction, Calculated by Eq. 39 (Boulanger and Idriss, 2008)
(5) Rod Length Correction for Samplers <10m in depth
(6) N-value corrected for energy, borehole diameter, sampler with absent liners, rod length, and overburden
(7) N-value corrected for fines content per Eqs. 75 and 76 (Boulanger and Idriss, 2008)
(8) Stress Reduction Coefficient calculated by Eq. 22 (Boulanger and Idriss, 2008)
(9) Magnitude Scaling Factor calculated by Eqs. A.8 & A.10 (Boulanger and Idriss, 2014)
(10) Overburden Correction Factor calculated by Eq. 54 (Boulanger and Idriss, 2008)
(11) Calculated by Eq. 70 (Boulanger and Idriss, 2008)
(12) Calculated by Eq. 72 (Boulanger and Idriss, 2008)
(13) Calculated by Eq. 25 (Boulanger and Idriss, 2008)
(14) Calculated by Eq. 86 (Boulanger and Idriss, 2008)
(15) Calculated by Eq. 93 (Boulanger and Idriss, 2008)
(16) Calculated by Eqs. 90, 91, and 92 (Boulanger and Idriss, 2008)
(17) Volumeteric Strain Induced in a Liquefiable Layer, Calculated by Eq. 96 (Boulanger and Idriss, 2008) (Strain N/A if Factor of Safety against Liquefaction > 1.3)

Layer No.	Depth to Top of Layer (ft)	Depth to Bottom of Layer (ft)	Soil Type (USCS)	Uncorrected SPT N-Value	Unit Weight of Soil (pcf)	Fines Content (%)	Energy Correction (1)	Depth to Soil Layer Midpoint (ft)	CB (2)	CS (3)	CN (4)	Rod Length Correction (5)	(N1)60 (6)	(N1)60CS (7)	Overburden Stress (σ) (psf)	Eff. Overburden Stress (Historical Water) (σ') (psf)	Eff. Overburden Stress (Current Water) (σ') (psf)	Stress Reduction Coefficient (rd) (8)	MSF (9)	Ks (10)	Cyclic Resistance Ratio (M=7.5) (11)	Cyclic Resistance Ratio (M=Design Magnitude) (12)	Cyclic Stress Ratio Induced by Design Earthquake (13)	Factor of Safety	Comments	Limiting Shear Strain γlim (14)	Parameter Rd (15)	Maximum Shear Strain γmax (16)	Height of Layers	Vertical Reconsolidation Strain εv (17)	Total Deformation of Layer (in)	Cumulative Settlement (in)
1	0	1	SC	42.0	120	43	1.3	0.50	1.15	1.30	1.00	0.75	61.3	66.9	60	60	60	1.01	1.08	-2.28	2.00	-4.93	0.39	-12.56	Liquefiable	0.00	-3.02	0.00	1.00	0.000	0.000	0.009
2	1	2	SC	43.6	120	43	1.3	1.50	1.15	1.30	1.26	0.75	80.2	85.8	180	180	180	1.00	1.08	0.39	2.00	0.84	0.39	2.14	Liquefiable	0.00	-4.73	0.00	1.00	>1.3	0.001	0.009
3	2	3	SC	45.2	120	43	1.3	2.50	1.15	1.30	1.21	0.75	79.5	85.1	300	300	300	1.00	1.08	0.51	2.00	1.09	0.39	2.80	Liquefiable	0.00	-4.67	0.00	1.00	>1.3	0.001	0.009
4	3	4	SC	46.8	120	43	1.3	3.50	1.15	1.30	1.17	0.75	79.6	85.2	420	420	420	1.00	1.08	0.59	2.00	1.29	0.39	3.30	Liquefiable	0.00	-4.67	0.00	1.00	>1.3	0.001	0.008
5	4	5	SC	48.4	120	43	1.3	4.50	1.15	1.30	1.14	0.75	80.1	85.7	540	540	540	1.00	1.08	0.67	2.00	1.44	0.39	3.71	Liquefiable	0.00	-4.72	0.00	1.00	>1.3	0.001	0.007
6	5	6	SC	50.0	120	43	1.3	5.50	1.15	1.30	1.11	0.75	80.8	86.4	660	660	660	0.99	1.08	0.72	2.00	1.57	0.39	4.05	Liquefiable	0.00	-4.79	0.00	1.00	>1.3	0.001	0.006
7	6	7	SC	50.0	120	43	1.3	6.50	1.15	1.30	1.10	0.75	79.9	85.5	780	780	780	0.99	1.08	0.76	2.00	1.64	0.39	4.25	Liquefiable	0.00	-4.70	0.00	1.00	>1.3	0.001	0.005
8	7	8	SC	50.0	120	43	1.3	7.50	1.15	1.30	1.08	0.75	79.0	84.6	900	900	900	0.99	1.08	0.79	2.00	1.70	0.38	4.43	Liquefiable	0.00	-4.62	0.00	1.00	>1.3	0.001	0.004
9	8	9	SC	50.0	120	43	1.3	8.50	1.15	1.30	1.07	0.75	78.2	83.8	1020	1020	1020	0.98	1.08	0.82	2.00	1.76	0.38	4.60	Liquefiable	0.00	-4.55	0.00	1.00	>1.3	0.001	0.003
10	9	10	SC	50.0	120	43	1.3	9.50	1.15	1.30	1.05	0.80	81.8	87.4	1140	1140	1140	0.98	1.08	0.86	2.00	1.87	0.38	4.89	Liquefiable	0.00	-4.87	0.00	1.00	>1.3	0.001	0.001
11	10	11	SWSM	50.0	120	7	1.3	10.50	1.15	1.30	1.04	0.80	81.1	81.3	1260	1229	1260	0.98	1.08	0.89	2.00	1.92	0.39	4.91	Liquefiable	0.00	-4.31	0.00	1.00	>1.3	0.000	0.000
12	11	12	SWSM	50.0	120	7	1.3	11.50	1.15	1.30	1.04	0.80	80.5	80.7	1380	1286	1380	0.97	1.08	0.91	2.00	1.96	0.41	4.82	Liquefiable	0.00	-4.26	0.00	1.00	>1.3	0.000	0.000
13	12	13	SWSM	50.0	120	7	1.3	12.50	1.15	1.30	1.02	0.85	84.5	84.6	1500	1344	1500	0.97	1.08	0.94	2.00	2.00	0.42	4.74	Liquefiable	0.00	-4.62	0.00	1.00	>1.3	0.000	0.000
14	13	14	SWSM	50.0	120	7	1.3	13.50	1.15	1.30	1.02	0.85	84.0	84.1	1620	1402	1620	0.97	1.08	0.95	2.00	2.00	0.44	4.59	Liquefiable	0.00	-4.58	0.00	1.00	>1.3	0.000	0.000
15	14	15	SWSM	50.0	120	7	1.3	14.50	1.15	1.30	1.01	0.85	83.5	83.7	1740	1459	1740	0.96	1.08	0.97	2.00	2.00	0.45	4.47	Liquefiable	0.00	-4.53	0.00	1.00	>1.3	0.000	0.000
16	15	16	SWSM	50.0	130	7	1.3	15.50	1.15	1.30	1.00	0.85	82.7	82.8	2015	1672	1984	0.96	1.08	1.00	2.00	2.00	0.45	4.44	Liquefiable	0.00	-4.45	0.00	1.00	>1.3	0.000	0.000
17	16	17	SWSM	50.0	130	7	1.3	16.50	1.15	1.30	1.00	0.85	82.4	82.6	2145	1739	2051	0.95	1.08	1.01	2.00	2.00	0.46	4.36	Liquefiable	0.00	-4.43	0.00	1.00	>1.3	0.000	0.000
18	17	18	SWSM	50.0	130	7	1.3	17.50	1.15	1.30	0.99	0.85	82.2	82.3	2275	1807	2119	0.95	1.08	1.01	2.00	2.00	0.47	4.28	Liquefiable	0.00	-4.41	0.00	1.00	>1.3	0.000	0.000
19	18	19	SWSM	50.0	130	7	1.3	18.50	1.15	1.30	0.99	0.85	81.9	82.1	2405	1875	2187	0.95	1.08	1.02	2.00	2.00	0.47	4.22	Liquefiable	0.00	-4.39	0.00	1.00	>1.3	0.000	0.000
20	19	20	SWSM	50.0	130	7	1.3	19.50	1.15	1.30	0.99	0.95	91.8	91.9	2535	1942	2254	0.94	1.08	1.02	2.00	2.00	0.48	4.17	Liquefiable	0.00	-5.30	0.00	1.00	>1.3	0.000	0.000
21	20	21	SWSM	50.0	130	7	1.3	20.50	1.15	1.30	0.99	0.95	91.6	91.8	2665	2010	2322	0.94	1.08	1.03	2.00	2.00	0.49	4.12	Liquefiable	0.00	-5.29	0.00	1.00	>1.3	0.000	0.000
22	21	22	SWSM	50.0	130	7	1.3	21.50	1.15	1.30	0.99	0.95	91.5	91.6	2795	2077	2389	0.93	1.08	1.03	2.00	2.00	0.49	4.08	Liquefiable	0.00	-5.28	0.00	1.00	>1.3	0.000	0.000
23	22	23	SWSM	50.0	130	7	1.3	22.50	1.15	1.30	0.99	0.95	91.4	91.5	2925	2145	2457	0.93	1.08	1.04	2.00	2.00	0.49	4.04	Liquefiable	0.00	-5.26	0.00	1.00	>1.3	0.000	0.000
24	23	24	SWSM	50.0	130	7	1.3	23.50	1.15	1.30	0.99	0.95	91.2	91.4	3055	2213	2525	0.93	1.08	1.04	2.00	2.00	0.50	4.01	Liquefiable	0.00	-5.25	0.00	1.00	>1.3	0.000	0.000
25	24	25	SWSM	50.0	130	7	1.3	24.50	1.15	1.30	0.99	0.95	91.1	91.2	3185	2280	2592	0.92	1.08	1.05	2.00	2.00	0.50	3.99	Liquefiable	0.00	-5.24	0.00	1.00	>1.3	0.000	0.000
26	25	26	SWSM	50.0	130	7	1.3	25.50	1.15	1.30	0.99	0.95	91.0	91.1	3315	2348	2660	0.92	1.08	1.05	2.00	2.00	0.50	3.96	Liquefiable	0.00	-5.23	0.00	1.00	>1.3	0.000	0.000
27	26	27	SWSM	50.0	130	7	1.3	26.50	1.15	1.30	0.98	0.95	90.8	91.0	3445	2415	2727	0.91	1.08	1.06	2.00	2.00	0.51	3.94	Liquefiable	0.00	-5.21	0.00	1.00	>1.3	0.000	0.000
28	27	28	SWSM	50.0	130	7	1.3	27.50	1.15	1.30	0.98	0.95	90.7	90.8	3575	2483	2795	0.91	1.08	1.06	2.00	2.00	0.51	3.92	Liquefiable	0.00	-5.20	0.00	1.00	>1.3	0.000	0.000
29	28	29	SWSM	50.0	130	7	1.3	28.50	1.15	1.30	0.98	0.95	90.6	90.7	3705	2551	2863	0.90	1.08	1.07	2.00	2.00	0.51	3.91	Liquefiable	0.00	-5.19	0.00	1.00	>1.3	0.000	0.000
30	29	30	SWSM	50.0	130	7	1.3	29.50	1.15	1.30	0.98	0.95	90.4	90.6	3835	2618	2930	0.90	1.08	1.07	2.00	2.00	0.51	3.90	Liquefiable	0.00	-5.18	0.00	1.00	>1.3	0.000	0.000
31	30	31	SWSM	50.0	130	7	1.3	30.50	1.15	1.30	0.98	0.95	90.3	90.5	3965	2686	2998	0.89	1.08	1.08	2.00	2.00	0.51	3.89	Liquefiable	0.00	-5.16	0.00	1.00	>1.3	0.000	0.000
32	31	32	SWSM	50.0	130	7	1.3	31.50	1.15	1.30	0.98	0.95	90.2	90.3	4095	2753	3065	0.89	1.08	1.08	2.00	2.00	0.52	3.88	Liquefiable	0.00	-5.15	0.00	1.00	>1.3	0.000	0.000
33	32	33	SWSM	50.0	130	7	1.3	32.50	1.15	1.30	0.99	1.00	95.8	95.9	4225	2821	3133	0.88	1.08	1.07	2.00	2.00	0.52	3.87	Liquefiable	0.00	-5.68	0.00	1.00	>1.3	0.000	0.000
34	33	34	SWSM	50.0	130	7	1.3	33.50	1.15	1.30	0.98	1.00	95.7	95.8	4355	2889	3201	0.88	1.08	1.08	2.00	2.00	0.52	3.87	Liquefiable	0.00	-5.67	0.00	1.00	>1.3	0.000	0.000
35	34	35	SWSM	50.0	130	7	1.3	34.50	1.15	1.30	0.98	1.00	95.6	95.7	4485	2956	3268	0.87	1.08	1.08	2.00	2.00	0.52	3.87	Liquefiable	0.00	-5.66	0.00	1.00	>1.3	0.000	0.000
36	35	36	SWSM	50.0	130	7	1.3	35.50	1.15	1.30	0.98	1.00	95.5	95.7	4615	3024	3336	0.87	1.08	1.08	2.00	2.00	0.52	3.86	Liquefiable	0.00	-5.66	0.00	1.00	>1.3	0.000	0.000
37	36	37	SWSM	50.0	130	7	1.3	36.50	1.15	1.30	0.98	1.00	95.5	95.6	4745	3091	3403	0.86	1.08	1.09	2.00	2.00	0.52	3.86	Liquefiable	0.00	-5.65	0.00	1.00	>1.3	0.000	0.000
38	37	38	SWSM	50.0	130	7	1.3	37.50	1.15	1.30	0.98	1.00	95.4	95.5	4875	3159	3471	0.86	1.08	1.09	2.00	2.00	0.52	3.87	Liquefiable	0.00	-5.64	0.00	1.00	>1.3	0.000	0.000
39	38	39	SWSM	50.0	130	7	1.3	38.50	1.15	1.30	0.98	1.00	95.3	95.4	5005	3227	3539	0.85	1.08	1.10	2.00	2.00	0.52	3.87	Liquefiable	0.00	-5.63	0.00	1.00	>1.3	0.000	0.000
40	39	40	SWSM	50.0	130	7	1.3	39.50	1.15	1.30	0.98	1.00	95.2	95.3	5135	3294	3606	0.85	1.08	1.10	2.00	2.00	0.52	3.87	Liquefiable	0.00	-5.63	0.00	1.00	>1.3	0.000	0.000
41	40	41	SWSM	50.0	130	7	1.3	40.50	1.15	1.30	0.98	1.00	95.1	95.3	5265	3362	3674	0.84	1.08	1.10	2.00	2.00	0.52	3.88	Liquefiable	0.00	-5.62	0.00	1.00	>1.3	0.000	0.000
42	41	42	SWSM	50.0	130	7	1.3	41.50	1.15	1.30	0.98	1.00	95.1	95.2	5395	3429	3741	0.84	1.08	1.10	2.00	2.00	0.52	3.88	Liquefiable	0.00	-5.61	0.00	1.00	>1.3	0.000	0.000
43	42	43	SWSM	50.0	130	7	1.3	42.50	1.15	1.30	0.98	1.00	95.0	95.1	5525	3497	3809	0.83	1.08	1.10	2.00	2.00	0.51	3.89	Liquefiable	0.00	-5.60	0.00	1.00	>1.3	0.000	0.000
44	43	44	SWSM	50.0	130	7	1.3	43.50	1.15	1.30	0.98	1.00	94.9	95.0	5655	3565	3877	0.83	1.08	1.10	2.00	2.00	0.51	3.89	Liquefiable	0.00	-5.60	0.00	1.00	>1.3	0.000	0.000
45	44	45	SWSM	50.0	130	7	1.3	44.50	1.15	1.30	0.98	1.00	94.8	95.0	5785	3632	3944	0.83	1.08	1.10	2.00	2.00	0.51	3.90	Liquefiable	0.00	-5.59	0.00	1.00	>1.3	0.000	0.000
46	45	46	SWSM	50.0	130	7	1.3	45.50	1.15	1.30	0.97	1.00	94.7	94.9	5915	3700	4012	0.82	1.08	1.10	2.00	2.00	0.51	3.91	Liquefiable	0.00	-5.58	0.00	1.00	>1.3	0.000	0.000
47	46	47	SWSM	50.0	130	7	1.3	46.50	1.15	1.30	0.97	1.00	94.7	94.8	6045	3767	4079	0.82	1.08	1.10	2.00	2.00	0.51	3.92	Liquefiable	0.00	-5.57	0.00	1.00	>1.3	0.000	0.000
48	47	48	SWSM	50.0	130	7	1.3	47.50	1.15	1.30	0.97	1.00	94.6	94.7	6175	3835	4147	0.81	1.08	1.10	2.00	2.00	0.51	3.93	Liquefiable	0.00	-5.57	0.00	1.00	>1.3	0.000	0.000
49	48	49	SWSM	50.0	130	7	1.3	48.50	1.15	1.30	0.97	1.00	94.5	94.6	6305	3903	4215	0.81	1.08	1.10	2.00	2.00	0.51	3.94	Liquefiable	0.00	-5.56	0.00	1.00	>1.3	0.000	0.000
50	49	50	SWSM	50.0	130	7	1.3	49.50	1.15	1.30	0.97	1.00	94.4	94.6	6435	3970	4282	0.80	1.08	1.10	2.00	2.00	0.51	3.95	Liquefiable	0.00	-5.55	0.00	1.00	>1.3	0.000	0.000
51	50	51	SWSM	50.0	130	7	1.3	50.50	1.15	1.30	0.97	1.00	94.3	94.5	6565	4038	4350	0.80	1.08	1.10	2.00	2.00	0.50	3.97	Liquefiable	0.00	-5.54	0.00	1.00	>1.3	0.000	0.000



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APPENDIX F

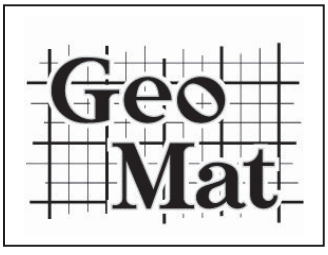


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GENERAL

The guidelines contained herein and the standard details attached hereto represent this firm's standard recommendation for grading and other associated operations on construction projects. These guidelines should be considered a portion of the project specifications.
All plates attached hereto shall be considered as part of these guidelines.
The Contractor should not vary from these guidelines without prior recommendation by the Geotechnical Consultant and the approval of the Client or his authorized representative. Recommendation by the Geotechnical Consultant and/or Client should not be considered to preclude requirements for the approval by the controlling agency prior to the execution of any changes.
These Standard Grading Guidelines and Standard Details may be modified and/or superseded by recommendations contained in the text of the preliminary Geotechnical Report and/or subsequent reports.
If disputes arise out of the interpretation of these grading guidelines or standard details, the Geotechnical Consultant shall provide the governing interpretation.

DEFINITION OF TERMS

ALLUVIUM
Unconsolidated soil deposits resulting from flow of water, including sediments deposited in river beds, canyons, flood plains, lakes, fans and estuaries.
AS-GRADED (AS-BUILT): The surface and subsurface conditions at completion of grading.
BACKCUT: A temporary construction slope at the rear of earth retaining structures such as buttresses, shear keys, stabilization fills or retaining walls.
BACKDRAIN: Generally a pipe and gravel or similar drainage system placed behind earth retaining structures such buttresses, stabilization fills, and retaining walls.
BEDROCK: Relatively undisturbed formational rock, more or less solid, either at the surface or beneath superficial deposits of soil.
BENCH: A relatively level step and near vertical rise excavated into sloping ground on which fill is to be placed.
BORROW (Import): Any fill material hauled to the project site from off-site areas.
BUTTRESS FILL::A fill mass, the configuration of which is designed by engineering calculations to retain slope conditions containing adverse geologic features. A buttress is generally specified by minimum key width and depth and by maximum backcut angle. A buttress normally contains a back-drainage system.
CIVIL ENGINEER: The Registered Civil Engineer or consulting firm responsible for preparation of the grading plans, surveying and verifying as-graded topographic conditions.
CLIENT: The Developer or his authorized representative who is chiefly in charge of the project. He shall have the responsibility of reviewing the findings and recommendations made by the Geotechnical Consultant and shall authorize the Contractor and/or other consultants to perform work and/or provide services.
COLLUVIUM: Generally loose deposits usually found near the base of slopes and brought there chiefly by gravity through slow continuous downhill creep (also see Slope Wash).
COMPACTION : Densification of man-placed fill by mechanical means.
CONTRACTOR – A person or company under contract or otherwise retained by the Client to perform demolition, grading and other site improvements.
DEBRIS: All products of clearing, grubbing, demolition, and contaminated soil materials unsuitable for reuse as compacted fill, and/or any other material so designated by the Geotechnical Consultant.
ENGINEERING GEOLOGIST: A Geologist holding a valid certificate of registration in the specialty of Engineering Geology.
ENGINEERED FILL: A fill of which the Geotechnical Consultant or his representative, during grading, has made sufficient tests to enable him to conclude that the fill has been placed in substantial compliance with the recommendations of the Geotechnical Consultant and the governing agency requirements.
EROSION: The wearing away of ground surface as a result of the movement of wind, water, and/or ice.
EXCAVATION: The mechanical removal of earth materials.
EXISTING GRADE: The ground surface configuration prior to grading.
FILL: Any deposits of soil, rock, soil-rock blends or other similar materials placed by man.
FINISH GRADE: The ground surface configuration at which time the surface elevations conform to the approved plan.

GEOFABRIC: Any engineering textile utilized in geotechnical applications including subgrade stabilization and filtering.
GEOLOGIST: A representative of the Geotechnical Consultant educated and trained in the field of geology.
GEOTECHNICAL CONSULTANT: The Geotechnical Engineering and Engineering Geology consulting firm retained to provide technical services for the project. For the purpose of these specifications, observations by the Geotechnical Consultant include observations by the Soil Engineer, Geotechnical Engineer, Engineering Geologist and those performed by persons employed by and responsible to the Geotechnical Consultants.
GEOTECHNICAL ENGINEER: A licensed Geotechnical Engineer or Civil Engineer who applies scientific methods, engineering principles and professional experience to the acquisition, interpretation and use of knowledge of materials of the earth's crust for the evaluation of engineering problems. Geotechnical Engineering encompasses many of the engineering aspects of soil mechanics, rock mechanics, geology, geophysics, hydrology and related sciences.
GRADING: Any operation consisting of excavation, filling or combinations thereof and associated operations.
LANDSIDE DEBRIS: Material, generally porous and of low density, produced from instability of natural or man-made slopes.
MAXIMUM DENSITY: Standard laboratory test for maximum dry unit weight. Unless otherwise specified, the maximum dry unity weight shall be determined in accordance with ASTM Method of Test D 1557-91.
OPTIMUM MOISTURE – Soil moisture content at the test maximum density.
RELATIVE COMPACTION: The degree of compaction (expressed as a percentage) of dry unit weight of a material as compared to the maximum dry unit weight of the material.
ROUGH GRADE: The ground surface configuration at which time the surface elevations approximately conform to the approved plan.
SITE: The particular parcel of land where grading is being performed.
SHEAR KEY: Similar to buttress, however, it is generally constructed by excavating a slot within a natural slope, in order to stabilize the upper portion of the slope without grading encroaching into the lower portion of the slope.
SLOPE: An inclined ground surface, the steepness of which is generally specified as a ration of horizontal:vertical (e.g., 2:1)
SLOPE WASH: Soil and/or rock material that has been transported down a slope by action of gravity assisted by runoff water not confined by channels (also see Colluvium).
SOIL: Naturally occurring deposits of sand, silt, clay, etc., or combinations thereof.
SOIL ENGINEER: Licensed Geotechnical Engineer or Civil Engineer experienced in soil mechanics (also see Geotechnical Engineer).
STABILIZATION FILL: A fill mass, the configuration of which is typically related to slope height and specified by the standards of practice for enhancing the stability of locally adverse conditions. A stabilization fill is normally specified by minimum key width and depth and by maximum backcut angle. A stabilization fill may or may not have a backdrainage system specified.
SUBDRAIN: Generally a pipe and gravel or similar drainage system placed beneath a fill in the alignment of canyons or formed drainage channels.
SLOUGH: Loose, non-compacted fill material generated during grading operations.
TAILINGS: Non-engineered fill which accumulates on or adjacent to equipment haul-roads.
TERRACE: Relatively level step constructed in the face of a graded slope surface for drainage control and maintenance purposes.
TOPSOIL: The presumable fertile upper zone of soil, which is usually darker in color and loose.
WINDROW: A string of large rocks buried within engineered fill in accordance with guidelines set forth by the Geotechnical Consultant.

OBLIGATIONS OF PARTIES

The Geotechnical Consultant should provide observation and testing services and should make evaluations in order to advise the Client on Geotechnical matters. The Geotechnical Consultant should report his findings and recommendations to the Client or his authorized representative.
The client should be chiefly responsible for all aspects of the project. He or his authorized representative has the responsibility of reviewing the findings and recommendations of the Geotechnical Consultant. He shall authorize or cause to have authorized the Contractor and/or other consultants to perform work and/or provide services.

During grading the Client or his authorized representative should remain on-site or should remain reasonably accessible to all concerned parties in order to make decisions necessary to maintain the flow of the project.
The Contractor should be responsible for the safety of the project and satisfactory completion of all grading and other associated operations on construction projects, including but not limited to, earthwork in accordance with the project plans, specifications and controlling agency requirements. During grading, the Contractor or his authorized representative should remain on-site. Overnight and on days off, the Contractor should remain accessible.

SITE PREPARATION

The Client, prior to any site preparation or grading, should arrange and attend a meeting among the Grading Contractor, the Design Engineer, the Geotechnical Consultant, representatives of the appropriate governing authorities as well as any other concerned parties. All parties should be given at least 48 hours notice.
Clearing and grubbing should consist of the removal of vegetation such as brush, grass, woods, stumps, trees, roots of trees and otherwise deleterious natural materials from the areas to be graded. Clearing and grubbing should extend to the outside of all proposed excavation and fill areas.
Demolition should include removal of buildings, structures, foundations, reservoirs, utilities (including underground pipelines, septic tanks, leach fields, seepage pits, cisterns, mining shafts, tunnels, etc.) and man-made surface and subsurface improvements from the areas to be graded. Demolition of utilities should include proper capping and/or re-routing pipelines at the project perimeter and cutoff and capping of wells in accordance with the requirements of the governing authorities and the recommendations of the Geotechnical Consultant at the time of the demolition.
Trees, plants or man-made improvements not planned to be removed or demolished should be protected by the Contractor from damage or injury.
Debris generated during clearing, grubbing and/or demolition operations should be wasted from areas to be graded and disposed off-site. Clearing, grubbing and demolition operations should be performed under the observation of the Geotechnical Consultant.
The Client or Contractor should obtain the required approvals for the controlling authorities for the project prior, during and/or after demolition, site preparation and removals, etc. The appropriate approvals should be obtained prior to proceeding with grading operations.

SITE PROTECTION

Protection of the site during the period of grading should be the responsibility of the Contractor. Unless other provisions are made in writing and agreed upon among the concerned parties, completion of a portion of the project should not be considered to preclude that portion or adjacent areas from the requirements for site protection until such time as the entire project is complete as identified by the Geotechnical Consultant, the Client and the regulating agencies.
The Contractor should be responsible for the stability of all temporary excavations. Recommendations by the Geotechnical Consultant pertaining to temporary excavations (e.g., backcuts) are made in consideration of stability of the completed project and therefore, should not be considered to preclude the responsibilities of the Contractor. Recommendations by the Geotechnical Consultant should not be considered to preclude more restrictive requirements by the regulating agencies.
Precautions should be taken during the performance of site clearing, excavations and grading to protect the work site from flooding, ponding, or inundation by poor or improper surface drainage. Temporary provisions should be made during the rainy season to adequately direct surface drainage away from and off the work site. Where low areas can not be avoided, pumps should be kept on hand to continually remove water during periods of rainfall.
During periods of rainfall, plastic sheeting should be kept reasonably accessible to prevent unprotected slopes from becoming saturated. Where necessary during periods of rainfall, the Contractor should install check-dams de-silting basins, rip-rap, sandbags or other devices or methods necessary to control erosion and provide safe conditions.
During periods of rainfall, the Geotechnical Consultant should be kept informed by the Contractor as to the nature of remedial or preventative work being performed (e.g., pumping, placement of sandbags or plastic sheeting, other labor, dozing, etc.).

Following periods of rainfall, the Contractor should contact the Geotechnical Consultant and arrange a walk-over of the site in order to visually assess rain related damage. The Geotechnical Consultant may also recommend excavations and testing in order to aid in his assessments. At the request of the Geotechnical Consultant, the Contractor shall make excavations in order to evaluate the extent of rain related damage.
Rain-related damage should be considered to include, but may not be limited to, erosion, silting, saturation, swelling, structural distress and other adverse conditions identified by the Geotechnical Consultant. Soil adversely affected should be classified as Unsuitable Materials and should be subject to overexcavation and replaced with compacted fill or other remedial grading as recommended by the Geotechnical Consultant.
Relatively level areas, where saturated soils and/or erosion gullies exist to depths greater then 1 foot, should be overexcavated to unaffected, competent material. Where less than 1 foot in depth, unsuitable materials may be processed in-place to achieve near optimum moisture conditions, then thoroughly recompacted in accordance with the applicable specifications. If the desired results are not achieved, the affected materials should be overexcavated then replaced in accordance with the applicable specifications.
In slope areas, where saturated soil and/or erosion gullies exist to depths of greater than 1 foot, should be over-excavated to unaffected, competent material. Where affected materials exist to depths of 1 foot or less below proposed finished grade, remedial grading by moisture conditioning in-place, followed by thorough recompaction in accordance with the applicable grading guidelines herein may be attempted. If the desired results are not achieved, all affected materials should be overexcavated and replaced as compacted fill in accordance with the slope repair recommendations herein. As field conditions dictate, other slope repair procedures may be recommended by the Geotechnical Consultant.

EXCAVATIONS

UNSUITABLE MATERIALS:
Materials which are unsuitable should be excavated under observation and recommendations of the Geotechnical Consultant. Unsuitable materials include, but may not be limited to dry, loose, soft, wet, organic compressible natural soils and fractured, weathered, soft, bedrock and nonengineered or otherwise deleterious fill materials.
Materials identified by the Geotechnical Consultant as unsatisfactory due to its moisture conditions should be overexcavated, watered or dried, as needed, and thoroughly blended to uniform near optimum moisture condition (per Moisture guidelines presented herein) prior to placement as compacted fill.

CUT SLOPES:
Unless otherwise recommended by the Geotechnical Consultant and approved by the regulating agencies, permanent cut slopes should not be steeper than 2:1 (horizontal:vertical).
If excavations for cut slopes expose loose, cohesionless, significantly fractured or otherwise suitable material, overexcavation and replacement of the unsuitable materials with a compacted stabilization fill should be accomplished as recommended by the Geotechnical Consultant. Unless otherwise specified by the Geotechnical Consultant, stabilization fill construction should conform to the requirements of the Standard Details.
The Geotechnical Consultant should review cut slopes during excavation. The Geotechnical Consultant should be notified by the contractor prior to beginning slope excavations.
If during the course of grading, adverse or potentially adverse geotechnical conditions are encountered which were not anticipated in the preliminary report, the Geotechnical Consultant should explore, analyze and make recommendations to treat these problems.
When cuts slopes are made in the direction of the prevailing drainage, a non-erodible diversion swale (brow ditch) should be provided at the top-of-cut.

PAD AREAS:
All lot pad areas, including side yard terraces, above stabilization fills or buttresses should be over-excavated to provide for a minimum of 3-feet (refer to Standard Details) of compacted fill over the entire pad area. Pad areas with both fill and cut materials exposed and pad areas containing both very shallow (less than 3-feet) and deeper fill should be over- thickness (refer to Standard Details).
Cut areas exposing significantly varying material types should also be overexcavated to provide for at least a 3-foot thick compacted fill blanket. Geotechnical conditions may require greater depth of overexcavation. The actual depth should be delineated by the Geotechnical Consultant during grading.

For pad areas created above cut or natural slopes, positive drainage should be established away from the top-of-slope. This may be accomplished utilizing a berm and/or an appropriate pad gradient. A gradient in soil areas away from the top-of-slope of 2 percent or greater is recommended.

COMPACTED FILL

All fill materials should be compacted as specified below or by other methods specifically recommended by the Geotechnical Consultant. Unless otherwise specified, the minimum degree of compaction (relative compaction) should be 90 percent of the laboratory maximum density.

PLACEMENT

Prior to placement of compacted fill, the Contractor should request a review by the Geotechnical Consultant of the exposed ground surface. Unless otherwise recommended, the exposed ground surface should then be scarified (6-inches minimum), watered or dried as needed, thoroughly blended to achieve near optimum moisture conditions, then thoroughly compacted to a minimum of 90 percent of the maximum density. The review by the Geotechnical Consultants should not be considered to preclude requirements of inspection and approval by the governing agency.

Compacted fill should be placed in thin horizontal lifts not exceeding 8-inches in loose thickness prior to compaction. Each lift should be watered or dried as needed, thoroughly blended to achieve near optimum moisture conditions then thoroughly compacted by mechanical methods to a minimum of 90 percent of laboratory maximum dry density. Each lift should be treated in a like manner until the desired finished grades are achieved.

The Contractor should have suitable and sufficient mechanical compaction equipment and watering apparatus on the job site to handle the amount of fill being placed in consideration of moisture retention properties of the materials. If necessary, excavation equipment should be “shut down” temporarily in order to permit proper compaction of fills. Earth moving equipment should only be considered a supplement and not substituted for conventional compaction equipment.

When placing fill in horizontal lifts adjacent to areas sloping steeper than 5:1 (horizontal:vertical), horizontal keys and vertical benches should be excavated into the adjacent slope area. Keying and benching should be sufficient to provide at least 6-foot wide benches and minimum of 4-feet of vertical bench height within the firm natural ground, firm bedrock or engineered compacted fill. No compacted fill should be placed in an area subsequent to keying and benching until the area has been reviewed by the Geotechnical Consultant. Material generated by the benching operation should be moved sufficiently away from the bench area to allow for the recommended review of the horizontal bench prior to placement of fill. Typical keying and benching details have been included within the accompanying Standard Details.

Within a single fill area where grading procedures dictate two or more separate fills, temporary slopes (false slopes) may be created. When placing fill adjacent to a false slope, benching should be conducted in the same manner as above described. At least a 3-foot vertical bench should be established within the firm core of adjacent approved compacted fill prior to placement of additional fill. Benching should proceed in at least 3-foot vertical increments until the desired finished grades are achieved.

Fill should be tested for compliance with the recommended relative compaction and moisture conditions. Field density testing should conform to ASTM Method of Testing D 1556-64, D 2922-78 and/or D2937-71. Tests should be provided for about every 2 vertical feet or 1,000 cubic yards of fill placed. Actual test intervals may vary as field conditions dictate. Fill found not to be in conformance with the grading recommendations should be removed or otherwise handled as recommended by the Geotechnical Consultant.

The Contractor should assist the Geotechnical Consultant and/or his representative by digging test pits for removal determinations and/or for testing compacted fill.

As recommended by the Geotechnical Consultant, the Contractor should “shutdown” or remove any grading equipment from an area being tested.

The Geotechnical Consultant should maintain a plan with estimated locations of field tests. Unless the client provides for actual surveying of test locations, by the Geotechnical Consultant should only be considered rough estimates and should not be utilized for the purpose of preparing cross sections showing test locations or in any case for the purpose of after-the-fact evaluating of the sequence of fill placement.

MOISTURE

For field testing purposes, “near optimum” moisture will vary with material type and other factors including compaction procedures. “Near optimum” may be specifically recommended in Preliminary Investigation Reports and/or may be evaluated during grading.

Prior to placement of additional compacted fill following an overnight or other grading delay, the exposed surface of previously compacted fill should be processed by scarification, watered or dried as needed, thoroughly blended to near-optimum moisture conditions, then recompacted to a minimum of 90 percent of laboratory maximum dry density. Where wet or other dry or other unsuitable materials exist to depths of greater than one foot, the unsuitable materials should be overexcavated.

Following a period of flooding, rainfall or overwatering by other means, no additional fill should be placed until damage assessments have been made and remedial grading performed as described herein.

FILL MATERIAL

Excavated on-site materials which are acceptable to the Geotechnical Consultant may be utilized as compacted fill, provided trash, vegetation and other deleterious materials are removed prior to placement.

Where import materials are required for use on-site, the Geotechnical Consultant should be notified at least 72 hours in advance of importing, in order to sample and test materials from proposed borrow sites. No import materials should be delivered for use on-site without prior sampling and testing by Geotechnical Consultant.

Where oversized rock or similar irreducible material is generated during grading, it is recommended, where practical, to waste such material off-site or on-site in areas designated as “nonstructural rock disposal areas”. Rock placed in disposal areas should be placed with sufficient fines to fill voids. The rock should be compacted in lifts to an unyielding condition. The disposal area should be covered with at least 3-feet of compacted fill, which is free of oversized material. The upper 3-feet should be placed in accordance with the guidelines for compacted fill herein.

Rocks 3 inches in maximum dimension and smaller may be utilized within the compacted fill, provided they are placed in such a manner that nesting of the rock in avoided. Fill should be placed and thoroughly compacted over and around all rock. The amount of rock should not exceed 40 percent by dry weight passing the $^{3}/_{4}$-inch sieve size. The 3-inch and 40 percent recommendations herein may vary as field conditions dictate.

During the course of grading operations, rocks or similar irreducible materials greater than 3-inch maximum dimension (oversized material) may be generated. These rocks should not be placed within the compacted fill unless placed as recommended by the Geotechnical Consultant.

Where rocks or similar irreducible materials of greater that 3-inches but less than 4-feet of maximum dimension are generated during grading, or otherwise desired to be placed within an engineered fill, special handling in accordance with the accompanying Standard Details is recommended. Rocks greater than 4 feet should be broken down or disposed off-site. Rocks up to 4-feet maximum dimension should be placed below the upper 10-feet of any fill and should not be closer than 20-feet to any slope face. These recommendations could vary as locations of improvements dictate. Where practical, oversized material should not be placed below areas where structures of deep utilities are proposes.

Oversized material should be placed in windrows on a clean, overexcavated or unyielding compacted fill or firm natural ground surface. Select native or imported granular soil (S.E. 30 or higher) should be placed and thoroughly flooded over and around all windrowed rock, such that voids are filled. Windrows of oversized material should be staggered so that successive strata of oversized material are not in the same vertical plane.

It may be possible to dispose of individual larger rock as field conditions dictate and as recommended by the Geotechnical Consultant at time of placement.

Material that is considered unsuitable by the Geotechnical Consultant should not be utilized in the compacted fill.

During grading operations, placing and mixing the materials from the cut and/or borrow areas may result in soil mixtures which possess unique physical properties. Testing may be required of samples obtained directly from the fill areas in order to verify conformance with the specifications. Processing of these additional samples may take two or more working days. The Contractor may elect to move the operation to other areas within the project, or may continue placing compacted fill pending laboratory and field test results. Should he elect the second alternative, fill placed is done so at the Contractor’s risk.

Any fill placed in areas not previously reviewed and evaluated by the Geotechnical Consultant, and/or in other areas, without prior notification to the Geotechnical Consultant may require removal and recompaction at the Contractor's expense. Determination of overexcavations should be made upon review of field conditions by the Geotechnical Consultant.

FILL SLOPES

Unless otherwise recommended by the Geotechnical Consultant and approved by the regulating agencies, permanent fill slopes should not be steeper than 2:1 (horizontal to vertical).

Except as specifically recommended otherwise or as otherwise provided for in these grading guidelines (Reference Fill Materials), compacted fill slopes should be overbuilt and cut back to grade, exposing the firm, compacted fill inner core. The actual amount of overbuilding may vary as field conditions dictate. If the desired results are not achieved, the existing slopes should be overexcavated and reconstructed under the guidelines of the Geotechnical Consultant. The degree of overbuilding shall be increased until the desired compacted slope surface condition is achieved. Care should be taken by the Contractor to provide thorough mechanical compaction to the outer edge of the overbuilt slope surface.

Although no construction procedure produces a slope free from risk of future movement, overfilling and cutting back of slope to a compacted inner core is, given no other constraints, the most desirable procedure. Other constraints, however, must often be considered. These constraints may include property line situations, access, the critical nature of the development, and cost. Where such constraints are identified, slope face compaction may be attempted by conventional construction procedures including backrolling techniques upon specific recommendations by the Geotechnical Consultant.

As a second best alternative for slopes of 2:1 (horizontal to vertical) or flatter, slope construction may be attempted as outlined herein. Fill placement should proceed in thin lifts, (i.e., 6 to 8 inch loose thickness). Each lift should be moisture conditioned and thoroughly compacted. The desired moisture condition should be maintained and/or reestablished, where necessary, during the period between successive lifts. Selected lifts should be tested to ascertain that desired compaction is being achieved. Care should be taken to extend compactive effort to the outer edge of the slope. Each lift should extend horizontally to the desired finished slope surface or more as needed to ultimately establish desired grades. Grade during construction should not be allowed to roll off at the edge of the slope. It may be helpful to elevate slightly the outer edge of the slope. Slough resulting from the placement of individual lifts should not be allowed to drift down over previous lifts. At intervals not exceeding 4-feet in vertical slope height or the capability of available equipment, whichever is less, fill slopes should be thoroughly backrolled utilizing a conventional sheepsfoot-type roller. Care should be taken to maintain the desired moisture conditions and/or reestablishing same as needed prior to backrolling. Upon achieving final grade, the slopes should again be moisture conditioned and thoroughly backrolled. The use of a side-boom roller will probably be necessary and vibratory methods are strongly recommended. Without delay, so as to avoid (if possible) further moisture conditioning, the slopes should then be grid-rolled to achieve a relatively smooth surface and uniformly compact condition.

In order to monitor slope construction procedures, moisture and density tests will be taken at regular intervals. Failure to achieve the desired results will likely result in a recommendation by the Geotechnical Consultant to overexcavate the slope surfaces followed by reconstruction of the slopes utilizing overfilling and cutting back procedures and/or further attempt at the conventional backrolling approach. Other recommendations may also be provided which would be commensurate with field conditions.

Where placement of fill above a natural slope or above a cut slope is proposed, the fill slope configuration as presented in the accompanying standard Details should be adopted.

For pad areas above fill slopes, positive drainage should be established away from the top-of-slope. This may be accomplished utilizing a berm and pad gradients of at least 2-percent in soil area.

OFF-SITE FILL

Off-site fill should be treated in the same manner as recommended in these specifications for site preparation, excavation, drains, compaction, etc.

Off-site canyon fill should be placed in preparation for future additional fill, as shown in the accompanying Standard Details.

Off-site fill subdrains temporarily terminated (up canyon) should be surveyed for future relocation and connection.

DRAINAGE

Canyon sub-drain systems specified by the Geotechnical Consultant should be installed in accordance with the Standard Details.
Typical sub-drains for compacted fill buttresses, slope stabilization or sidehill masses, should be installed in accordance with the specifications of the accompanying Standard Details.
Roof, pad and slope drainage should be directed away from slopes and areas of structures to suitable disposal areas via non-erodible devices (i.e., gutters, downspouts, concrete swales).
For drainage over soil areas immediately away from structures (i.e., within 4-feet), a minimum of 4 percent gradient should be maintained. Pad drainage of at least 2 percent should be maintained over soil areas. Pad drainage may be reduced to at least 1 percent for projects where no slopes exist, either natural or man-made, or greater than 10-feet in height and where no slopes are planned, either natural or man-made, steeper than 2:1 (horizontal to vertical slope ratio).
Drainage patterns established at the time of fine grading should be maintained throughout the life of the project. Property owners should be made aware that altering drainage patterns can be detrimental to slope stability and foundation performance.

STAKING

In all fill areas, the fill should be compacted prior to the placement of the stakes. This particularly is important on fill slopes. Slope stakes should not be placed until the slope is thoroughly compacted (backrolled). If stakes must be placed prior to the completion of compaction procedures, it must be recognized that they will be removed and/or demolished at such time as compaction procedures resume.
In order to allow for remedial grading operations, which could include overexcavations or slope stabilization, appropriate staking offsets should be provided. For finished slope and stabilization backcut areas, we recommend at least 10-feet setback from proposed toes and tops-of-cut.

SLOPE MAINTENANCE LANDSCAPE PLANTS

In order to enhance superficial slope stability, slope planting should be accomplished at the completion of grading. Slope planting should consist of deep-rooting vegetation requiring little watering. Plants native to the Southern California area and plants relative to native plants are generally desirable. Plants native to other semiarid and arid areas may also be appropriate. A Landscape Architect would be the best party to consult regarding actual types of plants and planting configuration.

IRRIGATION

Irrigation pipes should be anchored to slope faces, not placed in trenches excavated into slope faces.
Slope irrigation should be minimized. If automatic timing devices are utilized on irrigation systems, provisions should be made for interrupting normal irrigation during periods of rainfall.
Though not a requirement, consideration should be give to the installation of near-surface moisture monitoring control devices. Such devices can aid in the maintenance of relatively uniform and reasonably constant moisture conditions.
Property owners should be made aware that overwatering of slopes is detrimental to slope stability.

MAINTENANCE

Periodic inspections of landscaped slope areas should be planned and appropriate measures should be taken to control weeds and enhance growth of the landscape plants. Some areas may require occasional replanting and/or reseeding.
Terrace drains and downdrains should be periodically inspected and maintained free of debris. Damage to drainage improvements should be repaired immediately.
Property owners should be made aware that burrowing animals can be detrimental to slope stability. A preventative program should be established to control burrowing animals.
As a precautionary measure, plastic sheeting should be readily available, or kept on hand, to protect all slope areas from saturation by periods of heavy or prolonged rainfall. This measure is strongly recommended, beginning with the period of time prior to landscape planting.

REPAIRS

If slope failures occur, the Geotechnical Consultant should be contacted for a field review of site conditions and development of recommendations for evaluation and repair.

If slope failure occurs as a result of exposure to periods of heavy rainfall, the failure areas and currently unaffected areas should be covered with plastic sheeting to protect against additional saturation.

In the accompanying Standard Details, appropriate repair procedures are illustrated for superficial slope failures (i.e., occurring typically within the outer 1 foot to 3 feet of a slope face).

TRENCH BACKFILL

Utility trench backfill should, unless otherwise recommended, be compacted by mechanical means. Unless otherwise recommended, the degree of compaction should be a minimum of 95 percent of the laboratory maximum density.

Approved granular material (sand equivalent greater than 30) should be used to bed and backfill utilities to a depth of at least 1 foot over the pipe. This backfill should be uniformly watered, compacted and/or wheel-rolled from the surface to a firm condition for pipe support.

The remainder of the backfill shall be typical on-site soil or imported soil which should be placed in lifts not exceeding 8 inches in thickness, watered or aerated to at least 3 percent above the optimum moisture content, and mechanically compacted to at least 95 percent of maximum dry density (based on ASTM D1557).

Backfill of exterior and interior trenches extending below a 1:1 projection from the outer edge of foundations should be mechanically compacted to a minimum of 95 percent of the laboratory maximum density.

Within slab areas, but outside the influence of foundations, trenches up to 1 foot wide and 2 feet deep may be backfilled with sand and consolidated by uniformly watering or by mechanical means. If on-site materials are utilized, they should be wheel-rolled, tamped or otherwise compacted to a firm condition. For minor interior trenches, density testing may be deleted or spot testing may be elected if deemed necessary, based on review of back-fill operations during construction.

If utility contractors indicate that it is undesirable to use compaction equipment in close proximity to a buried conduit, the Contractor may elect the utilization of light weight compaction equipment and/or shading of the conduit with clean, granular material, which should be thoroughly jetted in-place above the conduit, prior to initiating mechanical compaction procedures. Other methods of utility trench compaction may also be appropriate, upon review by the Geotechnical Consultant at the time of construction.

In cases where clean granular materials are proposed for use in lieu of native materials or where flooding or jetting is proposed, the procedures should be considered subject to review by the Geotechnical Consultant.

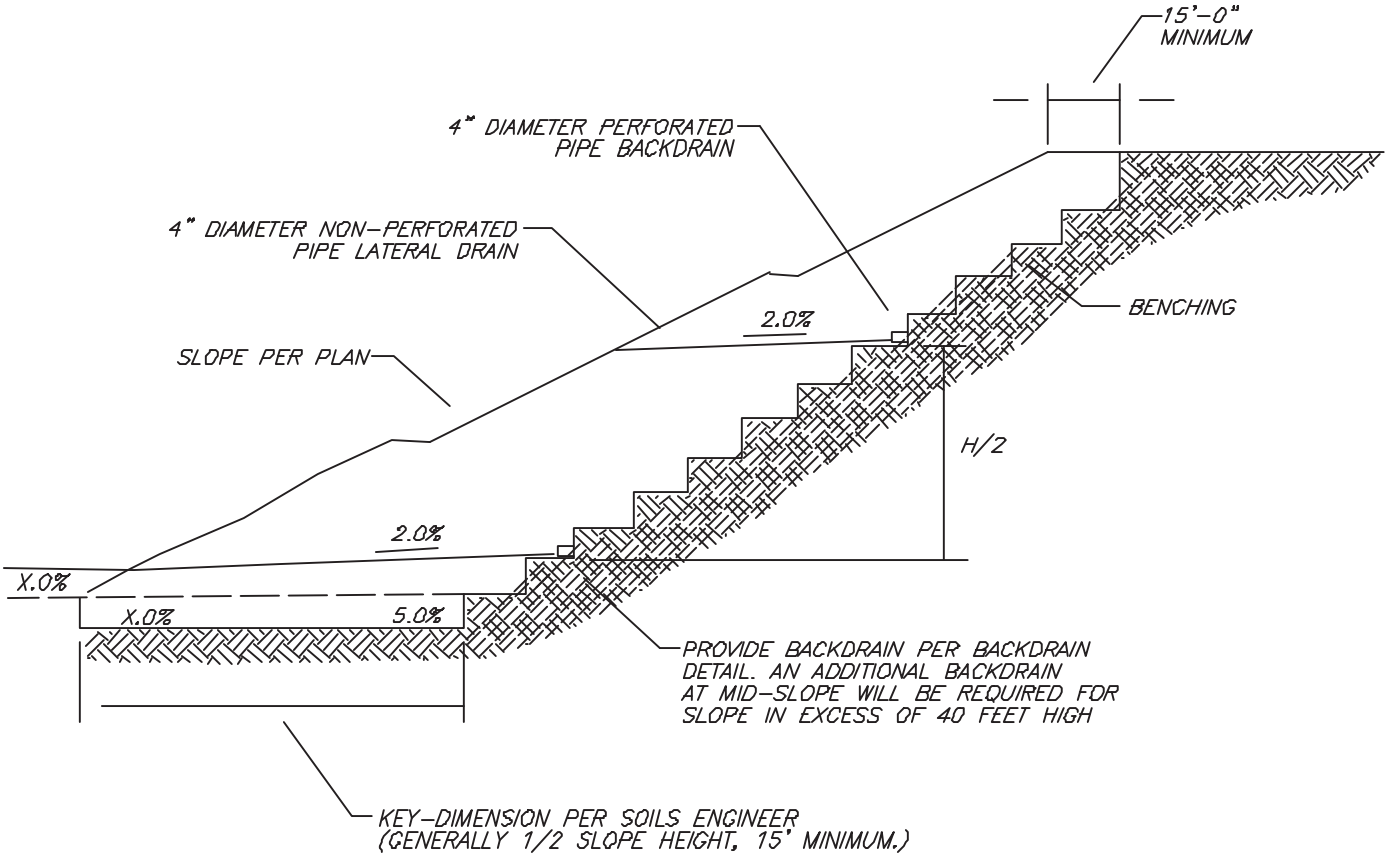
Clean Granular backfill and/or bedding are not recommended in slope areas unless provisions are made for a drainage system to mitigate the potential build-up of seepage forces.

STATUS OF GRADING

Prior to proceeding with any grading operation, the Geotechnical Consultant should be notified at least two working days in advance in order to schedule the necessary observation and testing services.

Prior to any significant expansion of cut back in the grading operation, the Geotechnical Consultant should be provided with adequate notice (i.e., two days) in order to make appropriate adjustments in observation and testing services.

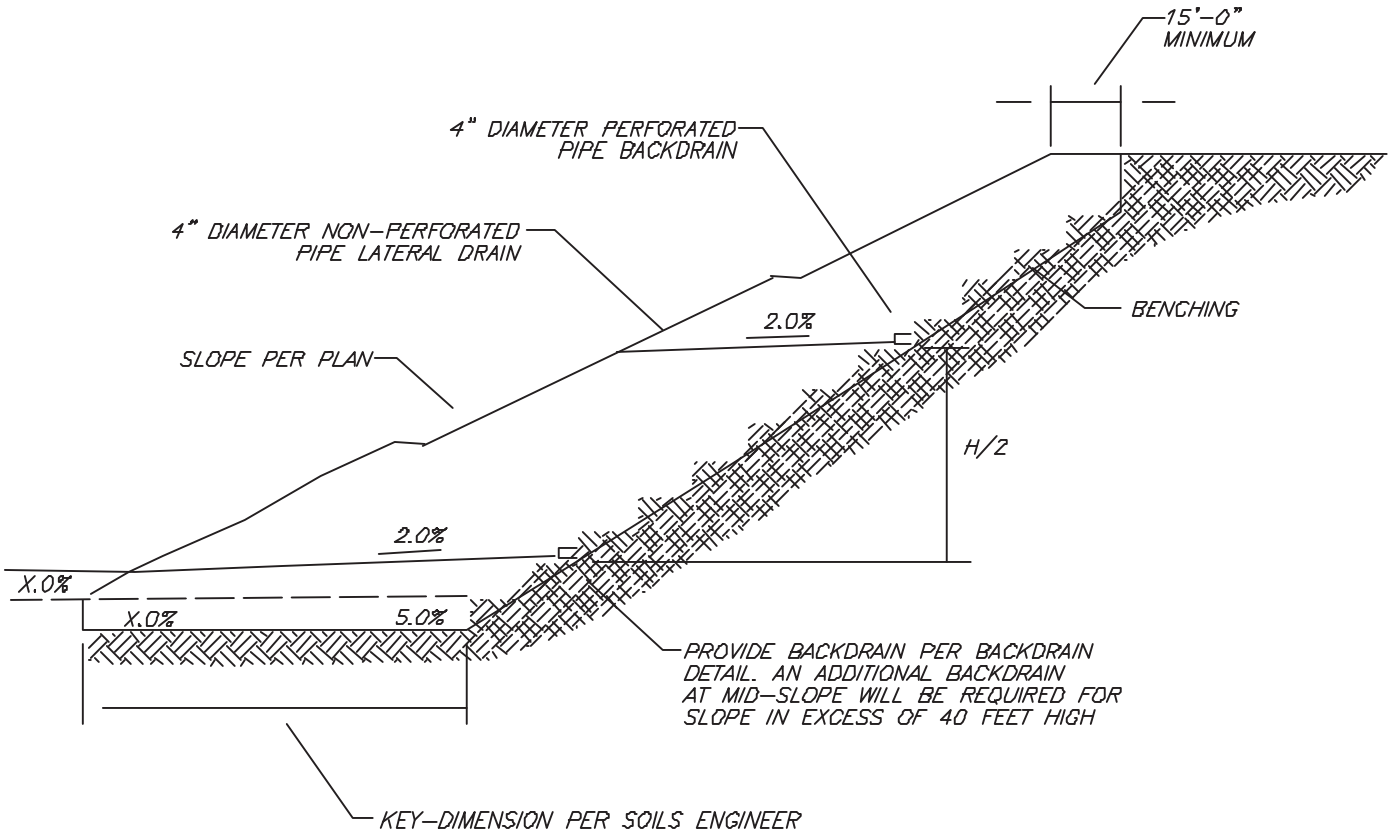
Following completion of grading operations and/or between phases of a grading operation, the Geotechnical Consultant should be provided with at least two working days notice in advance of commencement of additional grading operations.



geomat

TYPICAL STABILIZATION FILL DETAIL

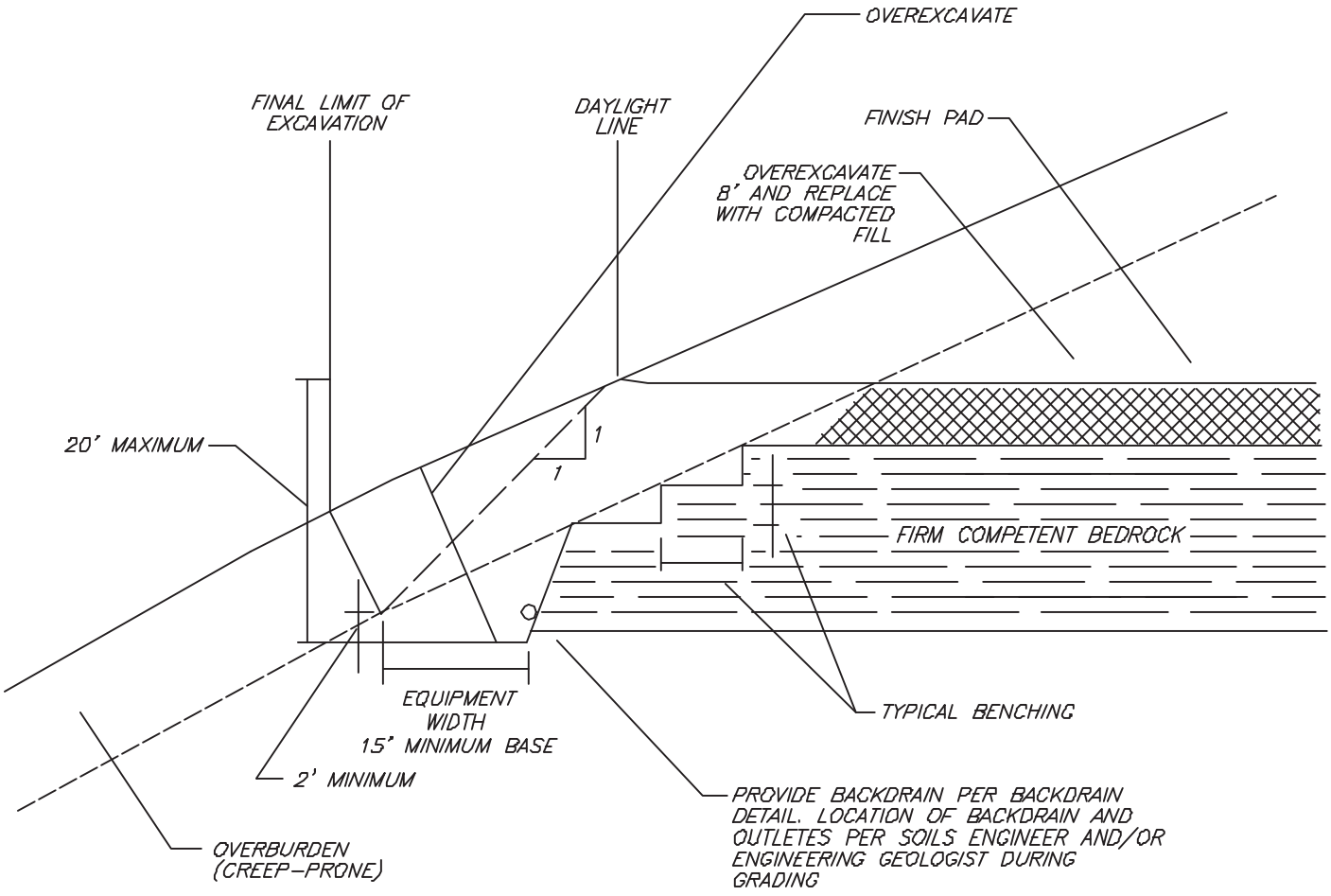
GENERAL EARTHWORK AND GRADING SPECIFICATIONS
SHEET 1



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TYPICAL BUTTRESS FILL DETAIL

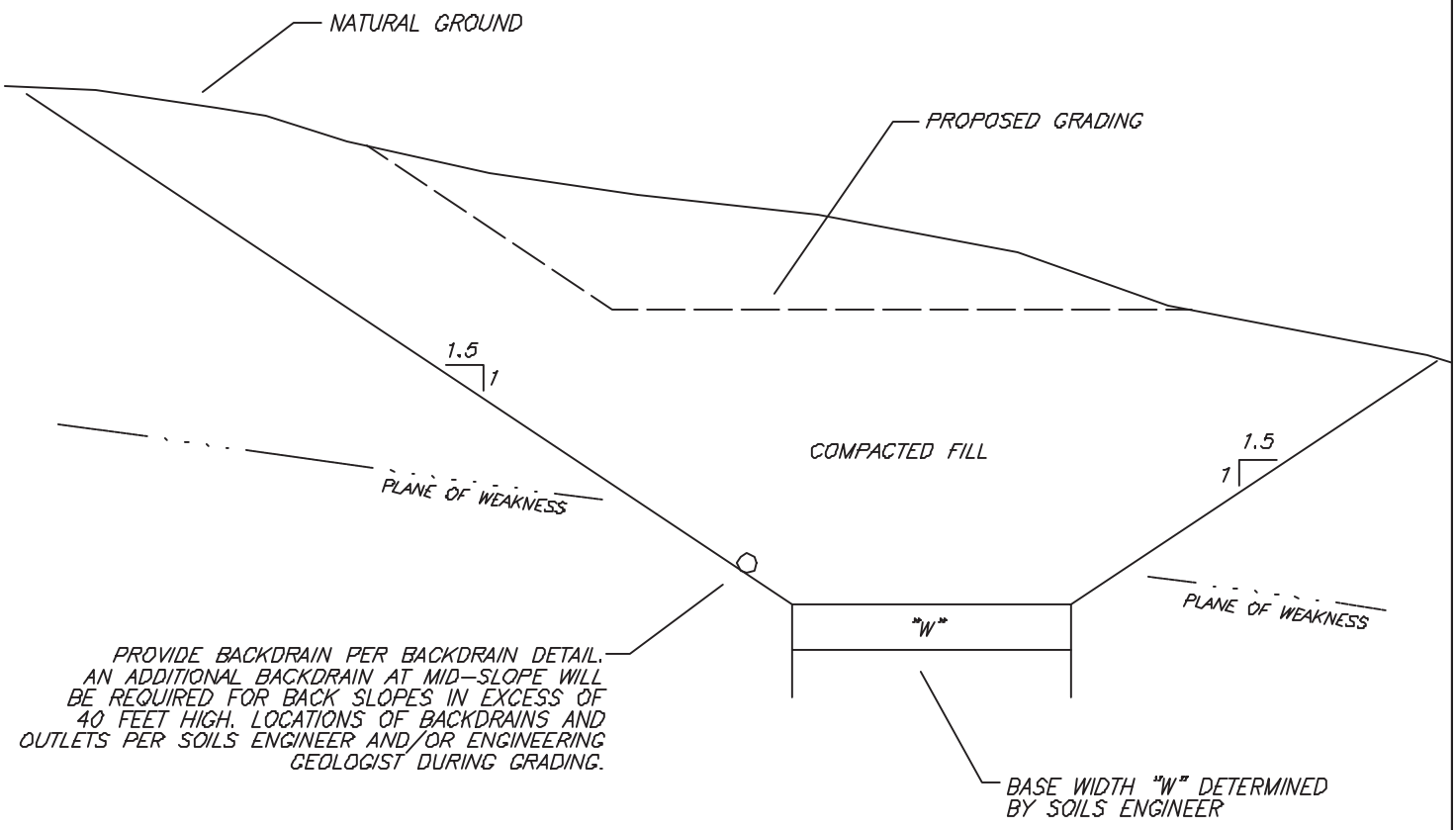
GENERAL EARTHWORK AND GRADING SPECIFICATIONS
SHEET 2



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DAYLIGHT SHEAR KEY DETAIL

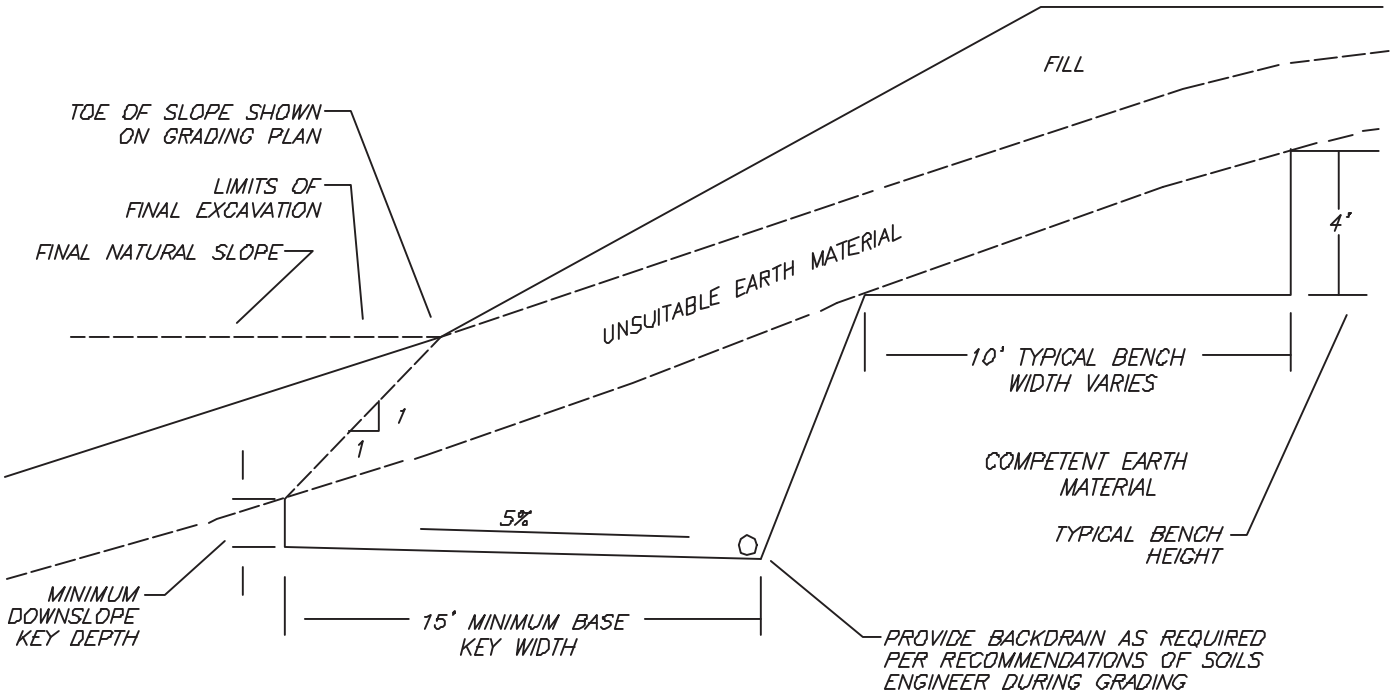
GENERAL EARTHWORK AND GRADING SPECIFICATIONS
SHEET 3



geomat

TYPICAL SHEAR KEY DETAIL

GENERAL EARTHWORK AND GRADING SPECIFICATIONS
SHEET 4

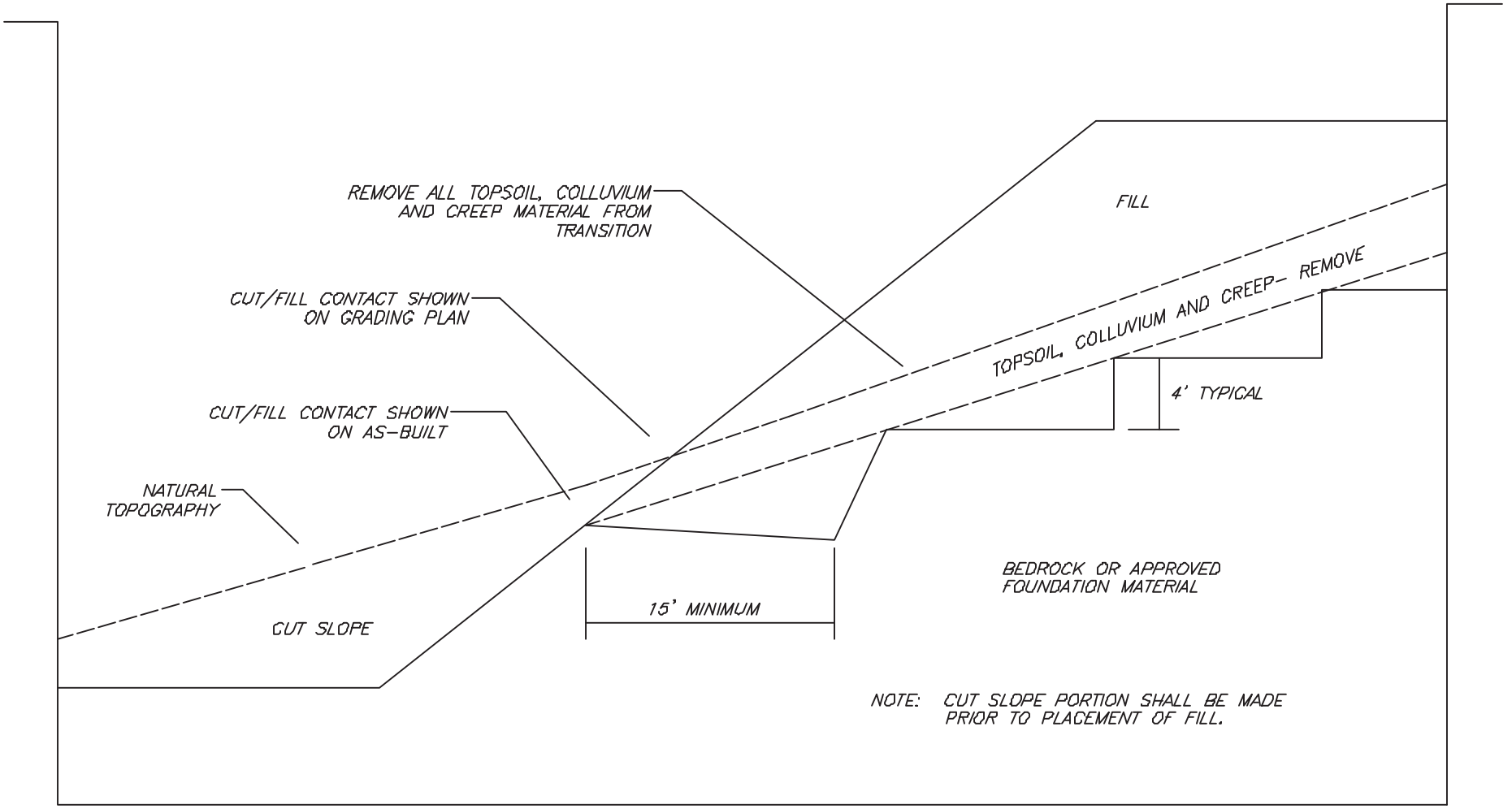


WHERE NATURAL SLOPE IS 5:1 OR LESS, BENCHING IS NOT NECESSARY, HOWEVER, FILL IS NOT TO BE PLACED ON COMPRESSIBLE OR UNSUITABLE MATERIAL.

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FILL SLOPE ABOVE NATURAL GROUND DETAIL

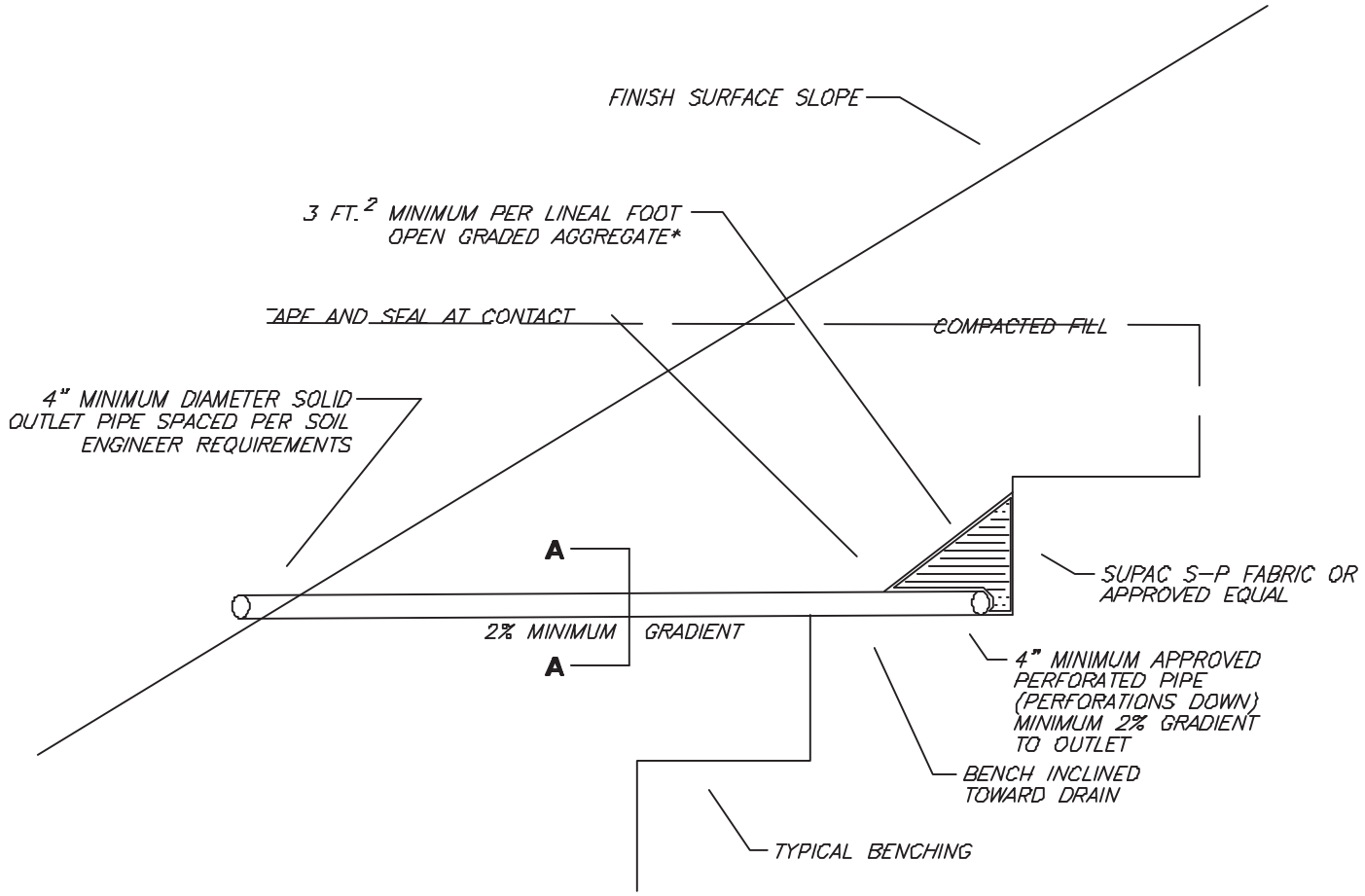
GENERAL EARTHWORK AND GRADING SPECIFICATIONS
SHEET 5



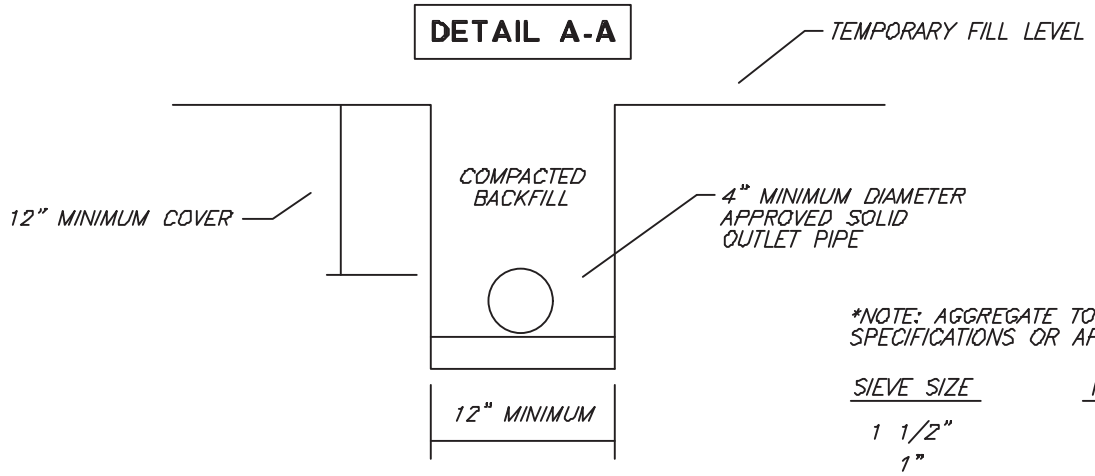
geomat

FILL SLOPE ABOVE CUT SLOPE DETAIL

GENERAL EARTHWORK AND GRADING SPECIFICATIONS
SHEET 6



DETAIL A-A



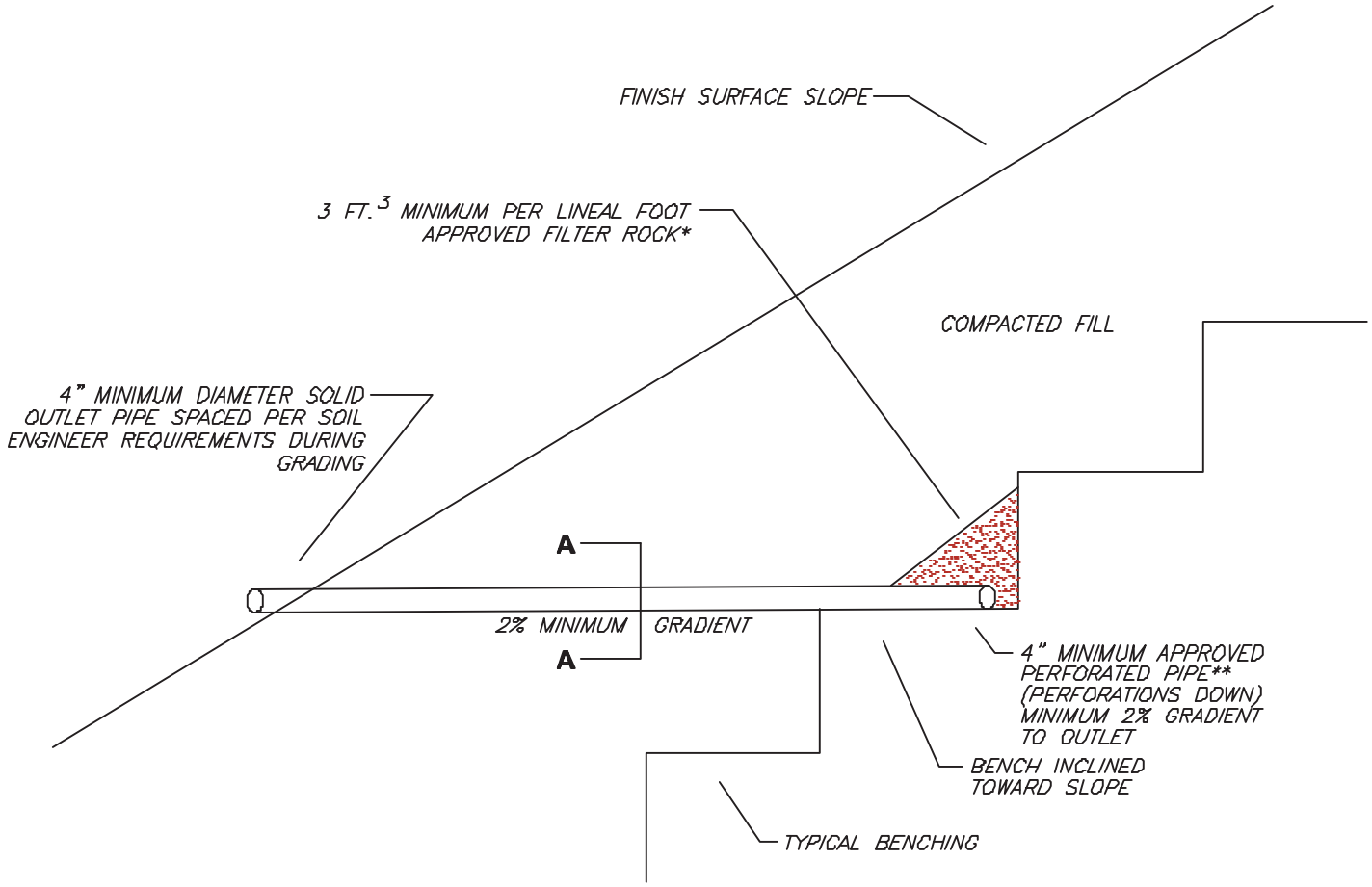
*NOTE: AGGREGATE TO MEET FOLLOWING SPECIFICATIONS OR APPROVED EQUAL:

SIEVE SIZE	PERCENTAGE PASSING
1 1/2"	100
1"	5-40
3/4"	0-17
3/8"	0-7
NO. 200	0-3

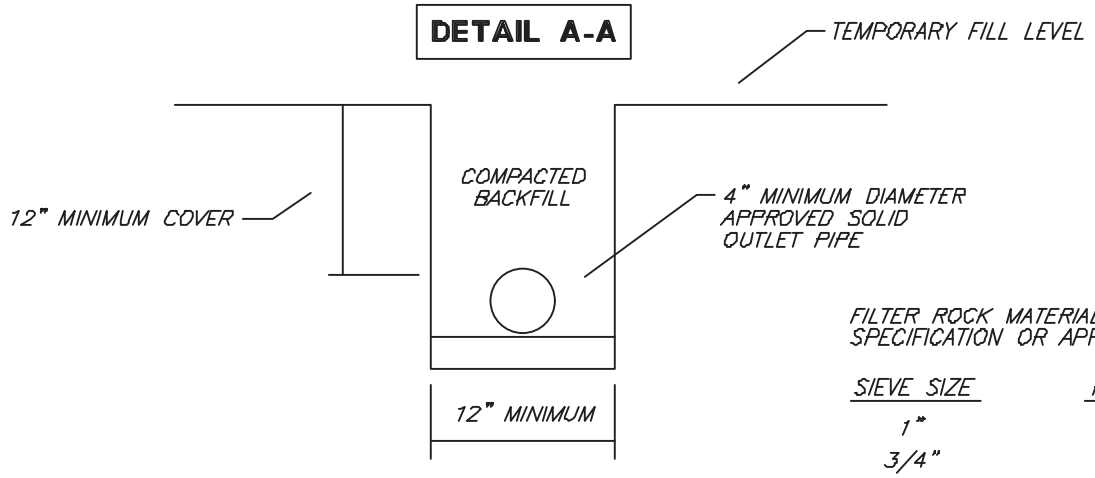
geomat

BACKDRAIN DETAIL (GEOFABRIC)

GENERAL EARTHWORK AND GRADING SPECIFICATIONS
SHEET 7



DETAIL A-A



FILTER ROCK MATERIAL TO MEET FOLLOWING SPECIFICATION OR APPROVED EQUAL:

SIEVE SIZE	PERCENTAGE
1"	100
3/4"	90–100
3/8"	40–100
NO. 4	25–40
NO. 30	5–15
NO. 50	0–7
NO. 200	0–3

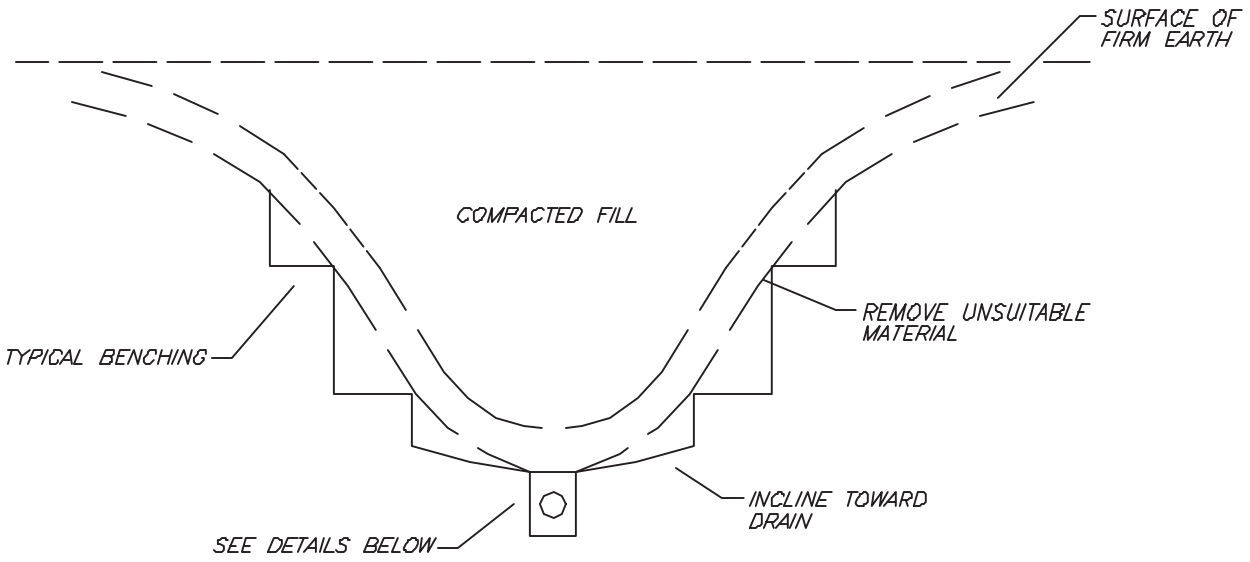
**APPROVED PIPE TYPE:

SCHEDULE 40 POLYVINYL CHLORIDE (P.V.C.) OR APPROVED EQUAL. MINIMUM CRUSH STRENGTH 1000 PSI.

geomat

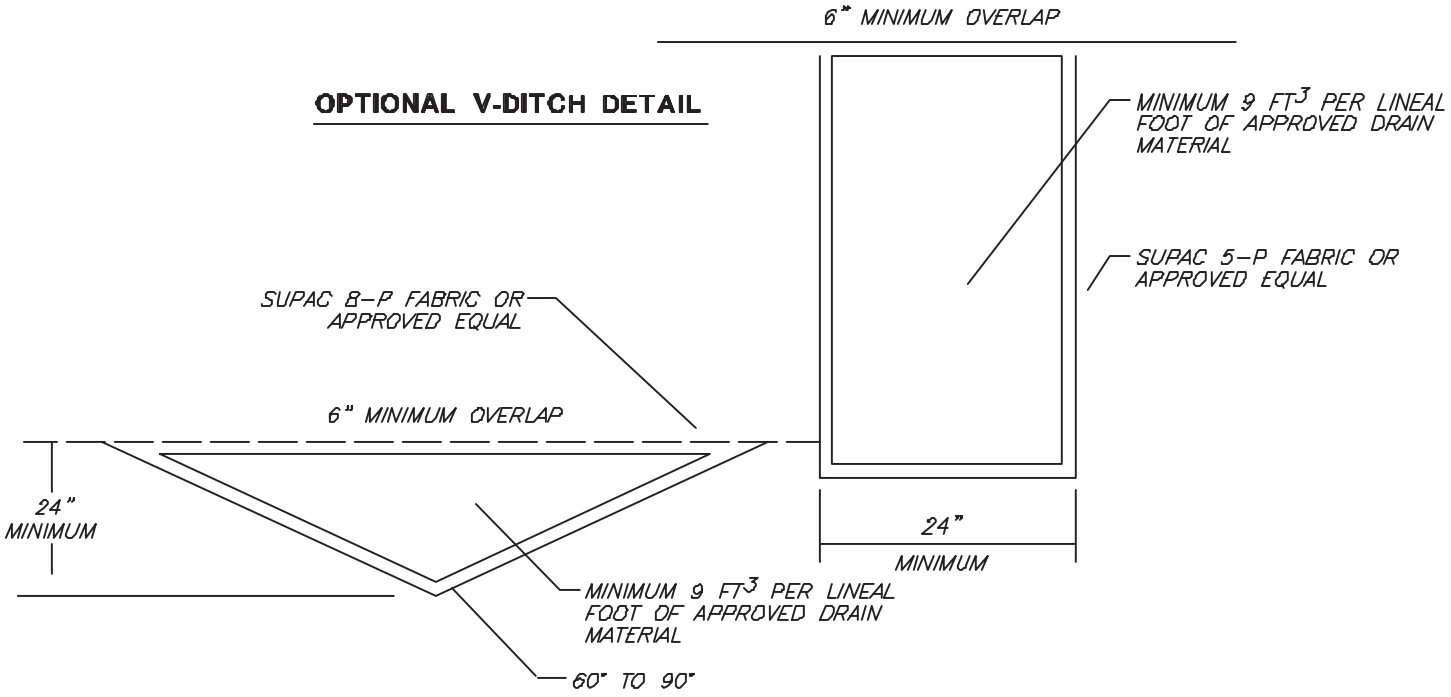
TYPICAL BACKDRAIN DETAIL

GENERAL EARTHWORK AND GRADING SPECIFICATIONS
SHEET 8



TRENCH DETAIL

OPTIONAL V-DITCH DETAIL



DRAIN MATERIAL TO MEET FOLLOWING SPECIFICATION OR APPROVED EQUAL:

SIEVE SIZE	PERCENTAGE PASSING
1-1/2"	88-100
1"	5-40
3/4"	0-17
3/8"	0-7
NO.:200	0-3

ADD MINIMUM 4" DIAMETER APPROVED PERFORATED PIPE WHEN GRADIENT IS LESS THAN 2%

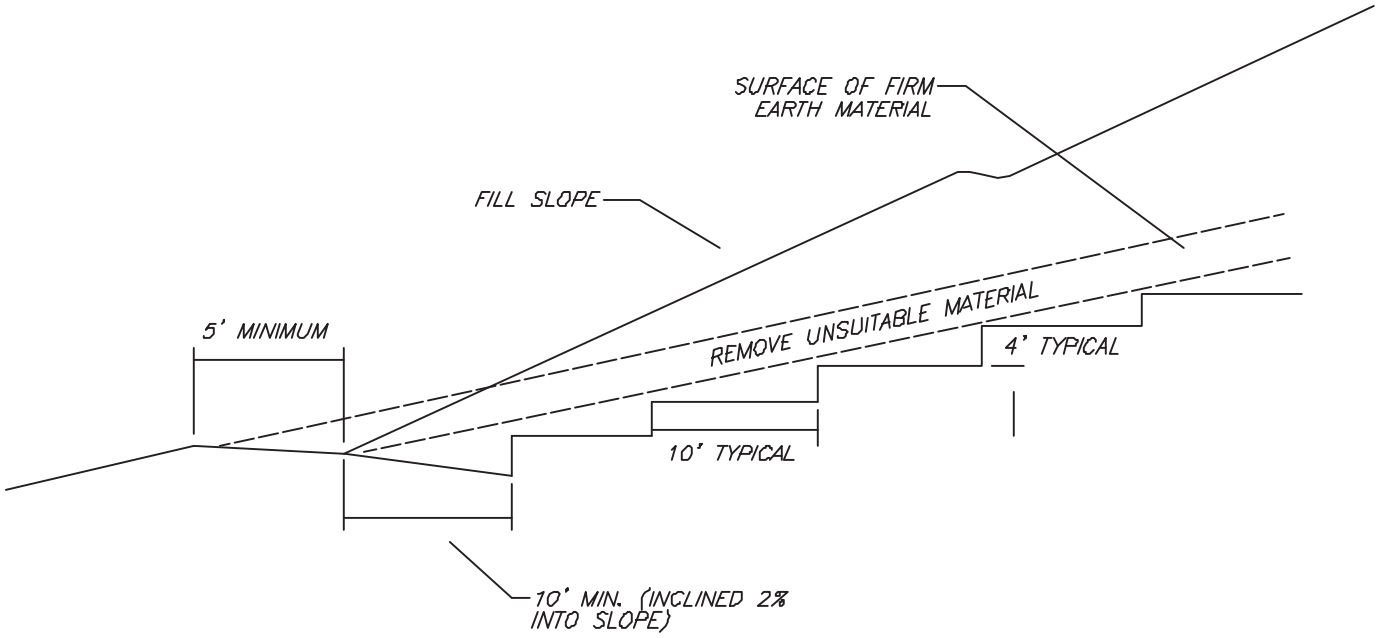
APPROVED PIPE TO BE SCHEDULE 40 POLY-VINYL-CHLORIDE (P.V.C.) OR APPROVED EQUAL. MINIMUM CRUSH STRENGTH 1000 psi.

geomat

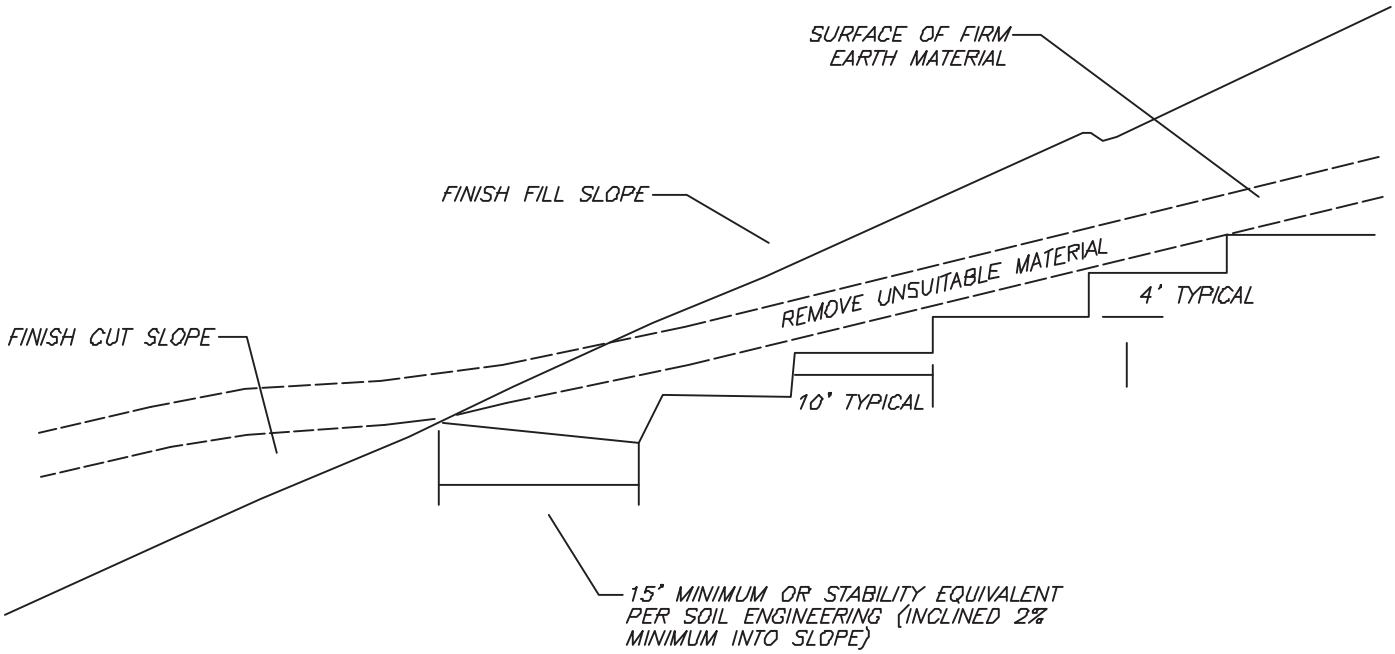
GEOFABRIC SUBDRAIN DETAIL

GENERAL EARTHWORK AND GRADING SPECIFICATIONS
SHEET 9

BENCHING FILL OVER NATURAL



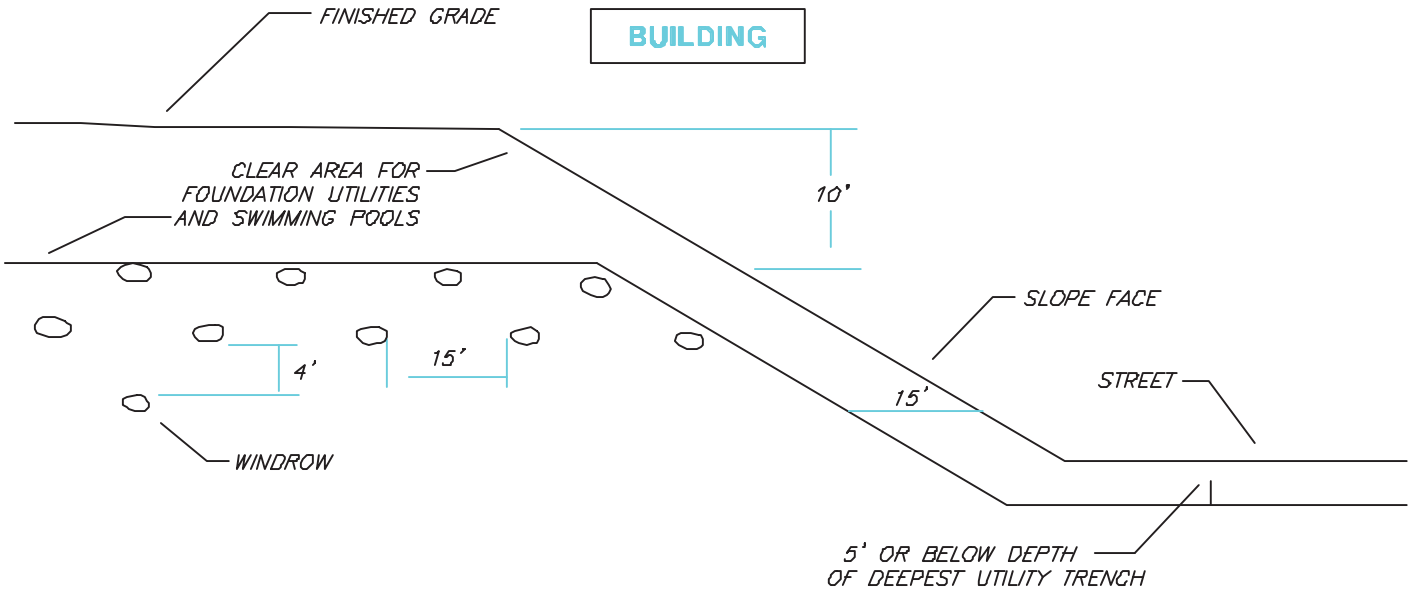
BENCHING FILL OVER CUT



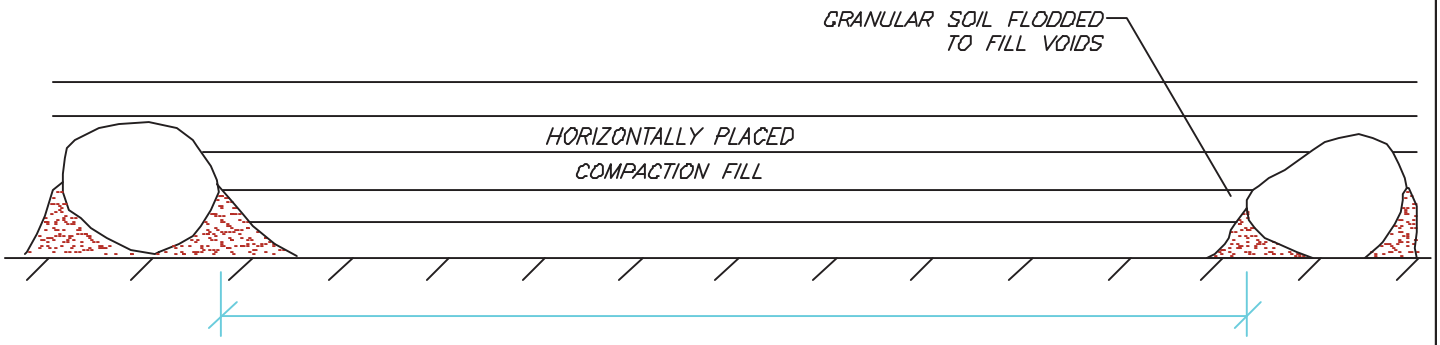
geomat

BENCHING FOR COMPACTED FILL DETAIL

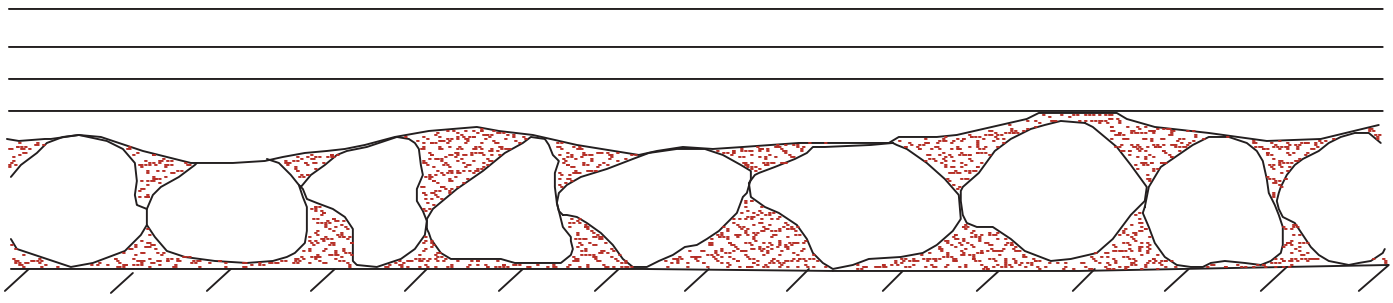
GENERAL EARTHWORK AND GRADING SPECIFICATIONS
SHEET 10



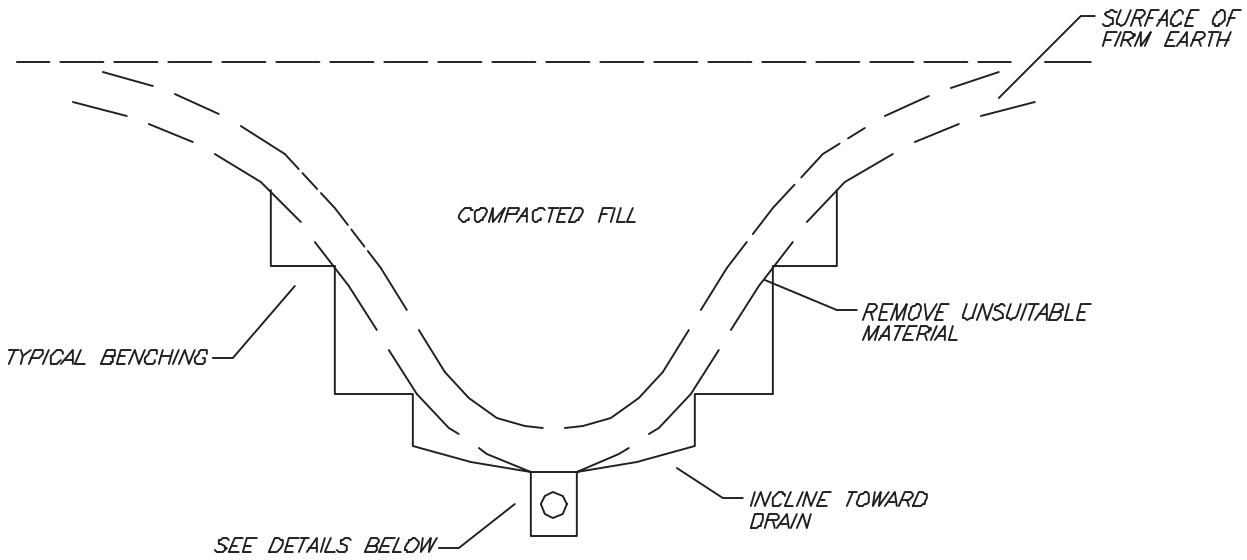
TYPICAL WINDROW DETAIL (EDGE VIEW)



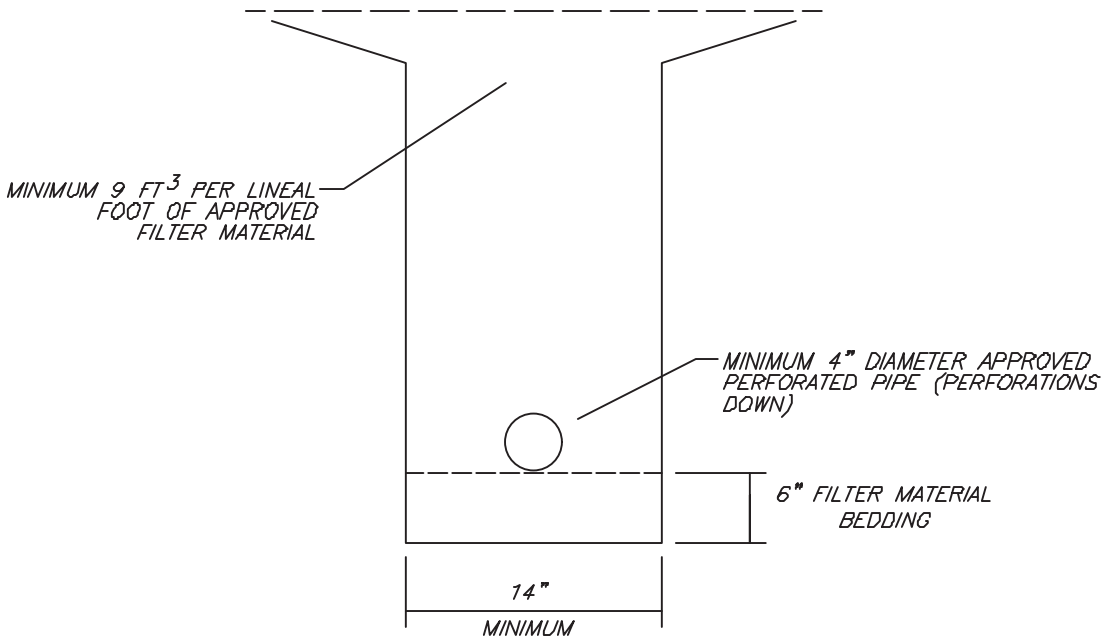
PROFILE VIEW



geomat	ROCK DISPOSAL DETAIL	GENERAL EARTHWORK AND GRADING SPECIFICATIONS SHEET 11



TRENCH DETAIL



FILTER MATERIAL TO MEET FOLLOWING SPECIFICATION OR APPROVED EQUAL:

SIEVE SIZE	PERCENTAGE
1"	100
3/4"	90–100
3/8"	40–100
NO. 4	25–40
NO. 30	5–15
NO. 50	0–7
NO. 200	0–3

APPROVED PIPE TO BE SCHEDULE 40 POLY–VINYL–CHLORIDE (P.V.C.) OR APPROVED EQUAL. MINIMUM CRUSH STRENGTH 1000 psi.

PIPE DIAMETER TO MEET THE FOLLOWING CRITERIA. SUBJECT TO FIELD REVIEW BASED ON ACTUAL GEOTECHNICAL CONDITIONS ENCOUNTERED DURING GRADING.

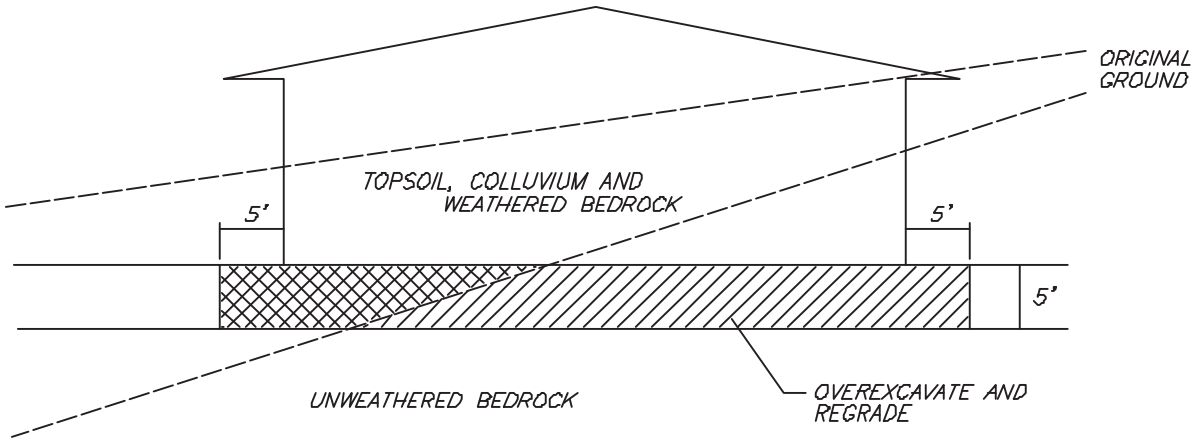
LENGTH OF RUN	PIPE DIAMETER
UPPER 500'	4"
NEXT 1000'	6"
> 1500'	8"

geomat

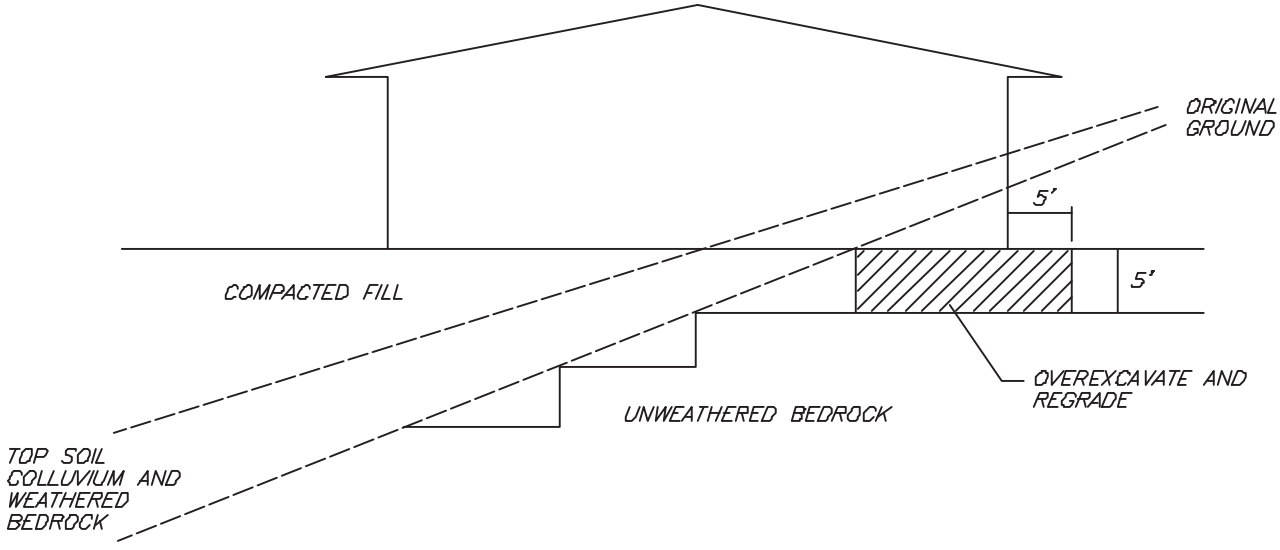
TYPICAL CANYON SUBDRAIN DETAIL

GENERAL EARTHWORK AND GRADING SPECIFICATIONS
SHEET 12

CUT LOT



CUT/FILL LOT (TRANSITION)

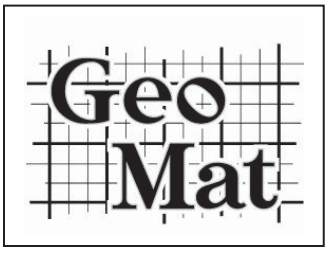


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TRANSITION LOT DETAIL

GENERAL EARTHWORK AND GRADING SPECIFICATIONS
SHEET 13

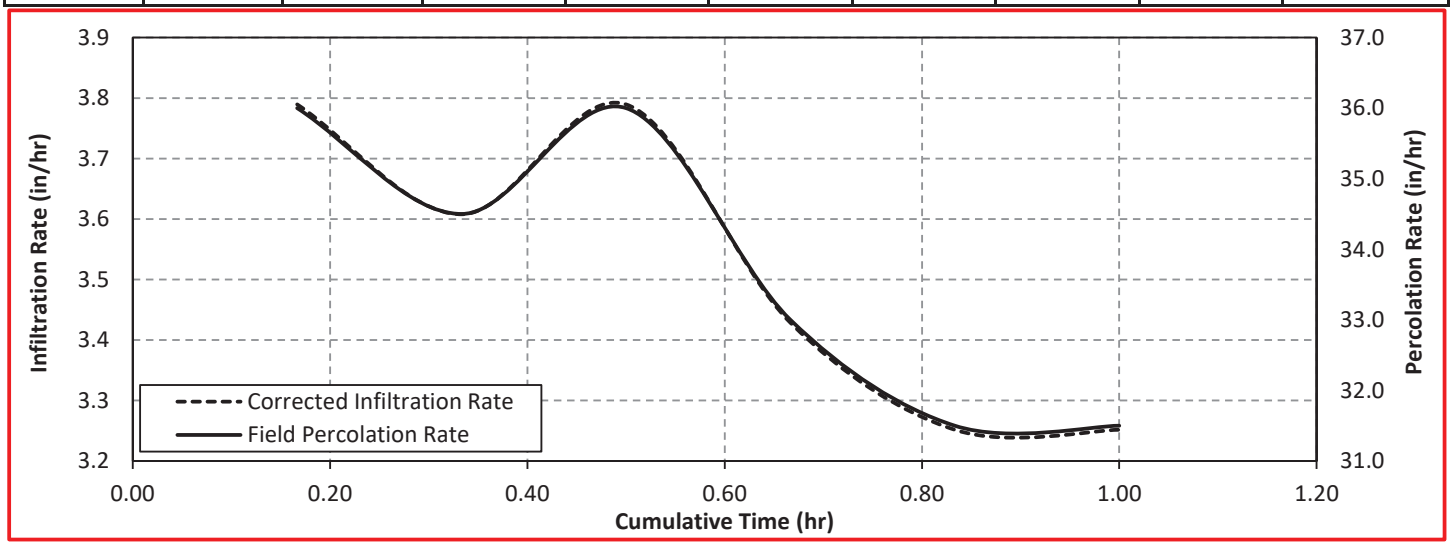
APPENDIX G



PERCOLATION TEST - P-1

Project No.	20112-01	Project Name	APN: 191-150-031, 032 & 033, Riverside, California		
Project Location	APN: 191-150-031, 032 & 033, Riverside, California			Soak Method	5 gallons
Drilling Date	4/16/2020	Soak Date	4/22/2020	Depth of Hole (in)	36
Testing Date	4/23/2020	Borehole Diameter (in)	8	Test Refill Depth (in)	20

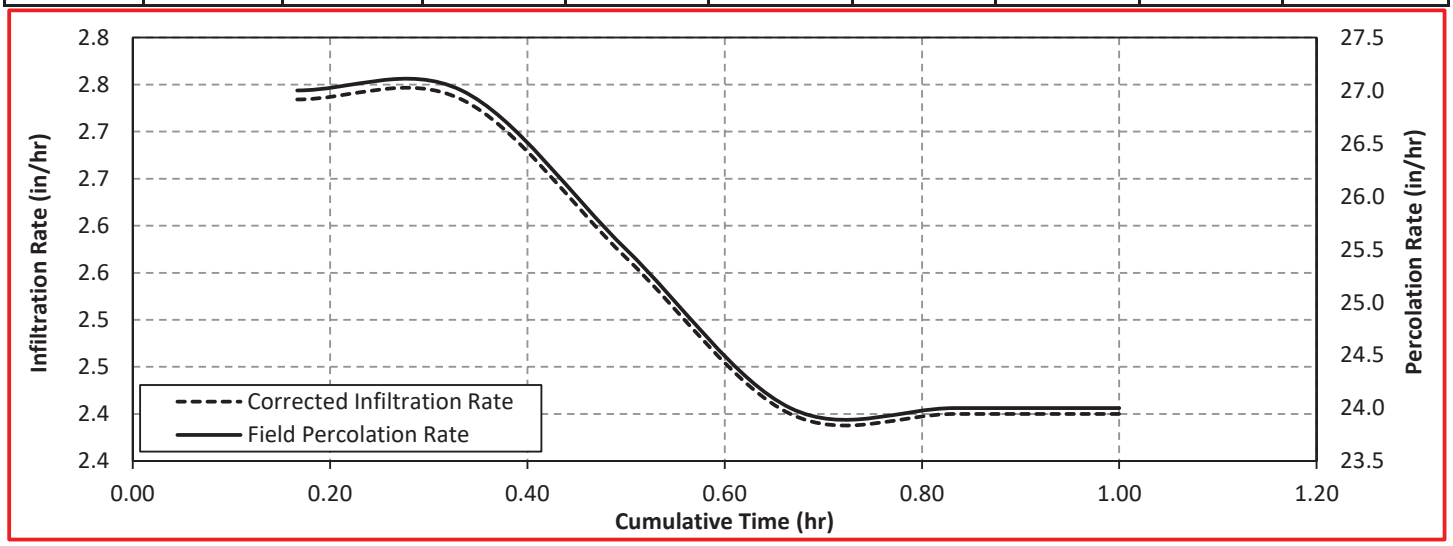
CRITERIA	TIME	TIME INTERVAL (min)	D_0, INITIAL DEPTH TO WATER (in)	D_f, FINAL DEPTH TO WATER (in)	ΔH, WATER DROP (in)	AVERAGE WETTED DEPTH (in)	PERC RATE (min/in)	PERC RATE (in/hr)	CORRECTED* INFILTRATION RATE (in/hr)
Sandy Soil Criteria	0:00:00	0:08:00	16	22	6	*Corrected utilizing the Porchet Method			
	0:08:00	8.00							
	0:00:00	0:09:00	16	22	6	Was Sandy Soil Criteria Met?			YES
	0:09:00	9.00							
Percolation Test Data	0:00:00	0:10:00	16	22	6	17	1.67	36.00	3.79
	0:10:00	10.00							
	0:00:00	0:10:00	16	21.75	5.75	17.125	1.74	34.50	3.61
	0:10:00	10.00							
	0:00:00	0:10:00	16	22	6	17	1.67	36.00	3.79
	0:10:00	10.00							
	0:00:00	0:10:00	16	21.5	5.5	17.25	1.82	33.00	3.43
	0:10:00	10.00							
	0:00:00	0:10:00	16	21.25	5.25	17.375	1.90	31.50	3.25
	0:10:00	10.00							
	0:00:00	0:10:00	16	21.25	5.25	17.375	1.90	31.50	3.25
	0:10:00	10.00							



PERCOLATION TEST - P-2

Project No.	20112-01	Project Name	APN: 191-150-031, 032 & 033, Riverside, California		
Project Location	APN: 191-150-031, 032 & 033, Riverside, California			Soak Method	5 gallons
Drilling Date	4/16/2020	Soak Date	4/22/2020	Depth of Hole (in)	24
Testing Date	4/23/2020	Borehole Diameter (in)	8	Test Refill Depth (in)	20

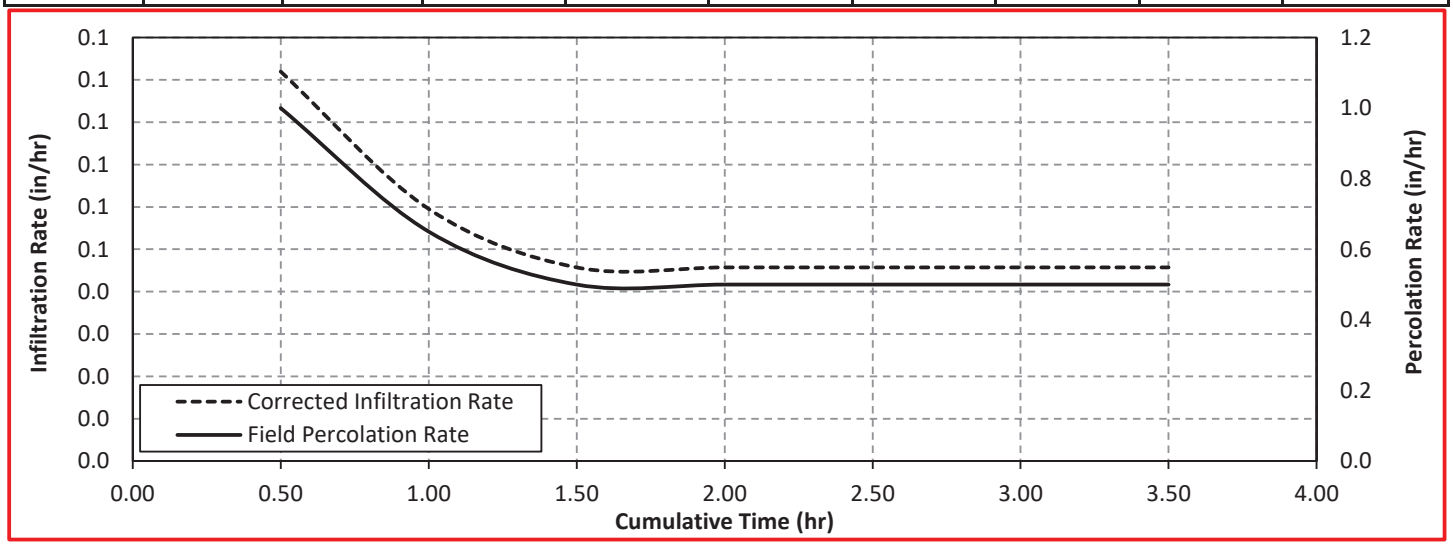
CRITERIA	TIME	TIME INTERVAL (min)	D_0, INITIAL DEPTH TO WATER (in)	D_f, FINAL DEPTH TO WATER (in)	ΔH, WATER DROP (in)	AVERAGE WETTED DEPTH (in)	PERC RATE (min/in)	PERC RATE (in/hr)	CORRECTED* INFILTRATION RATE (in/hr)
Sandy Soil Criteria	0:00:00	0:04:00	4	10	6	*Corrected utilizing the Porchet Method			
	0:04:00	4.00							
	0:00:00	0:08:00	4	10	6	Was Sandy Soil Criteria Met?			YES
	0:08:00	8.00							
Percolation Test Data	0:00:00	0:10:00	4	8.5	4.5	17.75	2.22	27.00	2.73
	0:10:00	10.00							
	0:00:00	0:10:00	4	8.5	4.5	17.75	2.22	27.00	2.73
	0:10:00	10.00							
	0:00:00	0:10:00	4	8.25	4.25	17.875	2.35	25.50	2.57
	0:10:00	10.00							
	0:00:00	0:10:00	4	8	4	18	2.50	24.00	2.40
	0:10:00	10.00							
	0:00:00	0:10:00	4	8	4	18	2.50	24.00	2.40
	0:10:00	10.00							
	0:00:00	0:10:00	4	8	4	18	2.50	24.00	2.40
	0:10:00	10.00							



PERCOLATION TEST - P-3

Project No.	20112-01	Project Name	APN: 191-150-031, 032 & 033, Riverside, California		
Project Location	APN: 191-150-031, 032 & 033, Riverside, California			Soak Method	5 gallons
Drilling Date	4/16/2020	Soak Date	4/22/2020	Depth of Hole (in)	108
Testing Date	4/23/2020	Borehole Diameter (in)	8	Test Refill Depth (in)	20

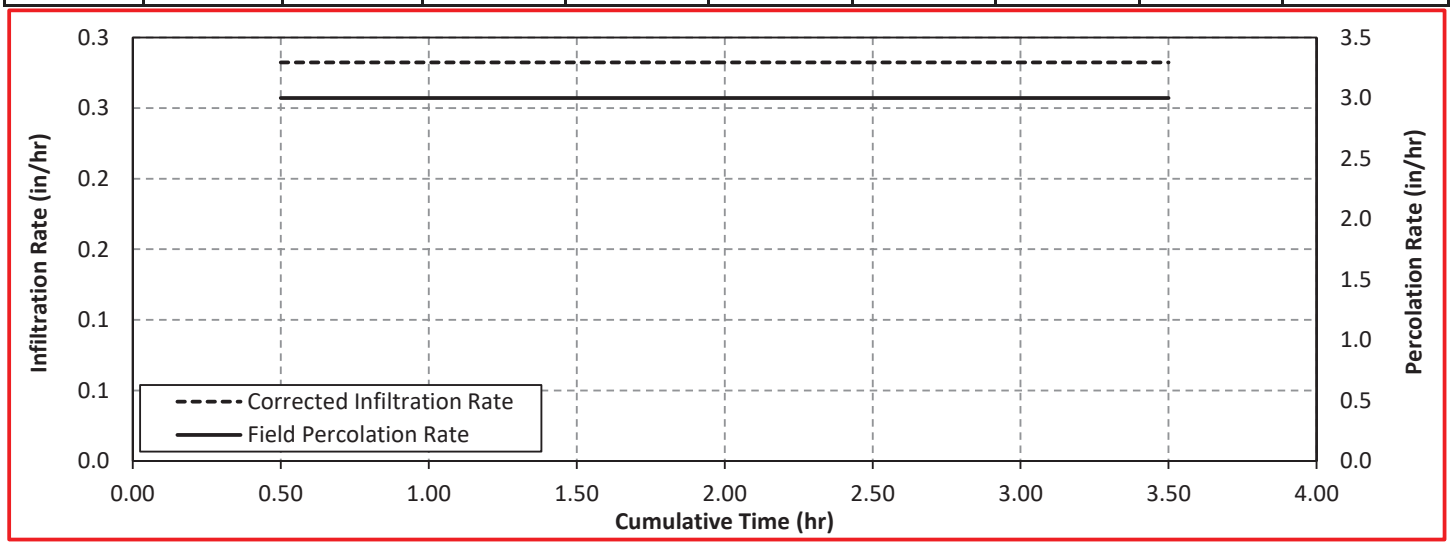
CRITERIA	TIME	TIME INTERVAL (min)	D_0, INITIAL DEPTH TO WATER (in)	D_f, FINAL DEPTH TO WATER (in)	ΔH, WATER DROP (in)	AVERAGE WETTED DEPTH (in)	PERC RATE (min/in)	PERC RATE (in/hr)	CORRECTED* INFILTRATION RATE (in/hr)
Sandy Soil Criteria						*Corrected utilizing the Porchet Method			
						Was Sandy Soil Criteria Met?			NO
Percolation Test Data	0:00:00	0:30:00	88	88.5	0.5	19.75	60.00	1.00	0.09
	0:30:00	30.00							
	0:00:00	0:30:00	88	88.325	0.325	19.8375	92.31	0.65	0.06
	0:30:00	30.00							
	0:00:00	0:30:00	88	88.25	0.25	19.875	120.00	0.50	0.05
	0:30:00	30.00							
	0:00:00	0:30:00	88	88.25	0.25	19.875	120.00	0.50	0.05
	0:30:00	30.00							
	0:00:00	0:30:00	88	88.25	0.25	19.875	120.00	0.50	0.05
	0:30:00	30.00							
	0:00:00	0:30:00	88	88.25	0.25	19.875	120.00	0.50	0.05
	0:30:00	30.00							
	0:00:00	0:30:00	88	88.25	0.25	19.875	120.00	0.50	0.05
	0:30:00	30.00							



PERCOLATION TEST - P-4

Project No.	20112-01	Project Name	APN: 191-150-031, 032 & 033, Riverside, California		
Project Location	APN: 191-150-031, 032 & 033, Riverside, California			Soak Method	5 gallons
Drilling Date	4/16/2020	Soak Date	4/22/2020	Depth of Hole (in)	108
Testing Date	4/23/2020	Borehole Diameter (in)	8	Test Refill Depth (in)	20

CRITERIA	TIME	TIME INTERVAL (min)	D_0, INITIAL DEPTH TO WATER (in)	D_f, FINAL DEPTH TO WATER (in)	ΔH, WATER DROP (in)	AVERAGE WETTED DEPTH (in)	PERC RATE (min/in)	PERC RATE (in/hr)	CORRECTED* INFILTRATION RATE (in/hr)
Sandy Soil Criteria						*Corrected utilizing the Porchet Method			
						Was Sandy Soil Criteria Met?			NO
Percolation Test Data	0:00:00	0:30:00	88	89.5	1.5	19.25	20.00	3.00	0.28
	0:30:00	30.00							
	0:00:00	0:30:00	88	89.5	1.5	19.25	20.00	3.00	0.28
	0:30:00	30.00							
	0:00:00	0:30:00	88	89.5	1.5	19.25	20.00	3.00	0.28
	0:30:00	30.00							
	0:00:00	0:30:00	88	89.5	1.5	19.25	20.00	3.00	0.28
	0:30:00	30.00							
	0:00:00	0:30:00	88	89.5	1.5	19.25	20.00	3.00	0.28
	0:30:00	30.00							
	0:00:00	0:30:00	88	89.5	1.5	19.25	20.00	3.00	0.28
	0:30:00	30.00							
	0:00:00	0:30:00	88	89.5	1.5	19.25	20.00	3.00	0.28
	0:30:00	30.00							



Appendix 4: Historical Site Conditions

Phase I Environmental Site Assessment or Other Information on Past Site Use

N/A

Appendix 5: LID Infeasibility

LID Technical Infeasibility Analysis

N/A

Appendix 6: BMP Design Details

BMP Sizing, Design Details and other Supporting Documentation

3.5 Bioretention Facility

Type of BMP	LID – Bioretention
Treatment Mechanisms	Infiltration, Evapotranspiration, Evaporation, Biofiltration
Maximum Drainage Area	This BMP is intended to be integrated into a project's landscaped area in a distributed manner. Typically, contributing drainage areas to Bioretention Facilities range from less than 1 acre to a maximum of around 10 acres.
Other Names	Rain Garden, Bioretention Cell, Bioretention Basin, Biofiltration Basin, Landscaped Filter Basin, Porous Landscape Detention

Description

Bioretention Facilities are shallow, vegetated basins underlain by an engineered soil media. Healthy plant and biological activity in the root zone maintain and renew the macro-pore space in the soil and maximize plant uptake of pollutants and runoff. This keeps the Best Management Practice (BMP) from becoming clogged and allows more of the soil column to function as both a sponge (retaining water) and a highly effective and self-maintaining biofilter. In most cases, the bottom of a Bioretention Facility is unlined, which also provides an opportunity for infiltration to the extent the underlying onsite soil can accommodate. When the infiltration rate of the underlying soil is exceeded, fully biotreated flows are discharged via underdrains. Bioretention Facilities therefore will inherently achieve the maximum feasible level of infiltration and evapotranspiration and achieve the minimum feasible (but highly biotreated) discharge to the storm drain system.

Siting Considerations

These facilities work best when they are designed in a relatively level area. Unlike other BMPs, Bioretention Facilities can be used in smaller landscaped spaces on the site, such as:

- ✓ Parking islands
- ✓ Medians
- ✓ Site entrances

Landscaped areas on the site (such as may otherwise be required through minimum landscaping ordinances), can often be designed as Bioretention Facilities. This can be accomplished by:

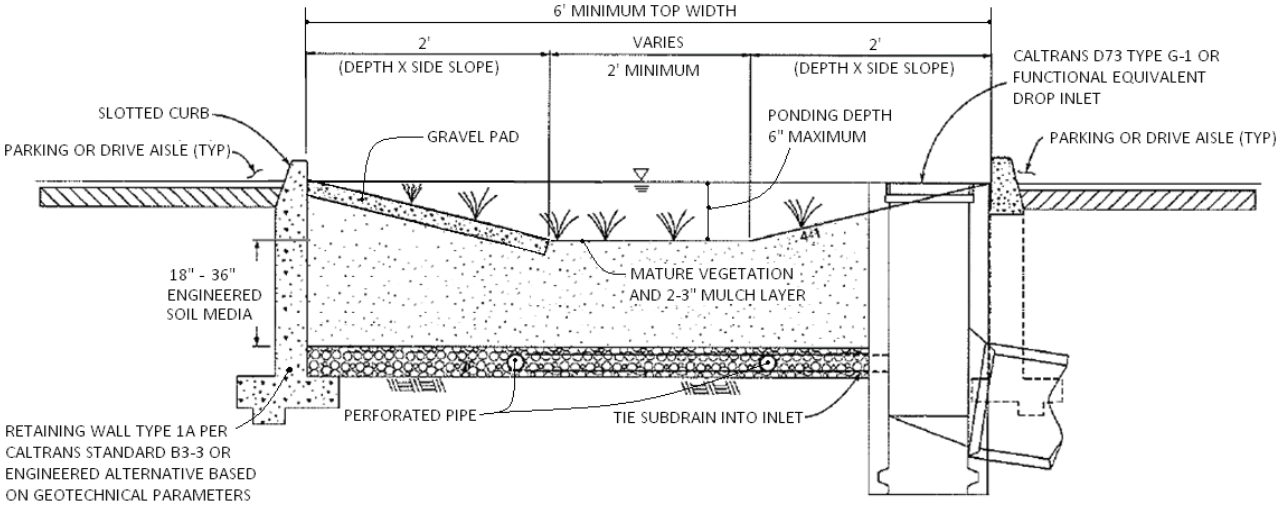
- *Depressing* landscaped areas below adjacent impervious surfaces, rather than elevating those areas
- Grading the site to direct runoff from those impervious surfaces *into* the Bioretention Facility, rather than away from the landscaping
- Sizing and designing the depressed landscaped area as a Bioretention Facility as described in this Fact Sheet

Bioretention Facilities should however not be used downstream of areas where large amounts of sediment can clog the system. Placing a Bioretention Facility at the toe of a steep slope should also be avoided due to the potential for clogging the engineered soil media with erosion from the slope, as well as the potential for damaging the vegetation.

Design and Sizing Criteria

The recommended cross section necessary for a Bioretention Facility includes:

- Vegetated area
- 18' minimum depth of engineered soil media
- 12' minimum gravel layer depth with 6' perforated pipes (added flow control features such as orifice plates may be required to mitigate for HCOC conditions)



While the 18-inch minimum engineered soil media depth can be used in some cases, it is recommended to use 24 inches or a preferred 36 inches to provide an adequate root zone for the chosen plant palate. Such a design also provides for improved removal effectiveness for nutrients. The recommended ponding depth inside of a Bioretention Facility is 6 inches; measured from the flat bottom surface to the top of the water surface as shown in Figure 1.

Because this BMP is filled with an engineered soil media, pore space in the soil and gravel layer is assumed to provide storage volume. However, several considerations must be noted:

- Surcharge storage above the soil surface (6 inches) is important to assure that design flows do not bypass the BMP when runoff exceeds the soil's absorption rate.
- In cases where the Bioretention Facility contains engineered soil media deeper than 36 inches, the pore space within the engineered soil media can only be counted to the 36-inch depth.
- A maximum of 30 percent pore space can be used for the soil media whereas a maximum of 40 percent pore space can be use for the gravel layer.

Figure 1: Standard Layout for a Bioretention Facility

Engineered Soil Media Requirements

The engineered soil media shall be comprised of 85 percent mineral component and 15 percent organic component, by volume, drum mixed prior to placement. The mineral component shall be a Class A sandy loam topsoil that meets the range specified in Table 1 below. The organic component shall be nitrogen stabilized compost[1], such that nitrogen does not leach from the media.

Table 1: Mineral Component Range Requirements

Percent Range	Component
70-80	Sand
15-20	Silt
5-10	Clay

The trip ticket, or certificate of compliance, shall be made available to the inspector to prove the engineered mix meets this specification.

Vegetation Requirements

Vegetative cover is important to minimize erosion and ensure that treatment occurs in the Bioretention Facility. The area should be designed for at least 70 percent mature coverage throughout the Bioretention Facility. To prevent the BMP from being used as walkways, Bioretention Facilities shall be planted with a combination of small trees, densely planted shrubs, and natural grasses. Grasses shall be native or ornamental; preferably ones that do not need to be mowed. The application of fertilizers and pesticides should be minimal. To maintain oxygen levels for the vegetation and promote biodegradation, it is important that vegetation not be completely submerged for any extended period of time. Therefore, a maximum of 6 inches of ponded water shall be used in the design to ensure that plants within the Bioretention Facility remain healthy.

A 2 to 3-inch layer of standard shredded aged hardwood mulch shall be placed as the top layer inside the Bioretention Facility. The 6-inch ponding depth shown in Figure 1 above shall be measured from the top surface of the 2 to 3-inch mulch layer.

Curb Cuts

To allow water to flow into the Bioretention Facility, 1-foot-wide (minimum) curb cuts should be placed approximately every 10 feet around the perimeter of the Bioretention Facility. Figure 2 shows a curb cut in a Bioretention Facility. Curb cut flow lines must be at or above the V_{BMP} water surface level.

[1] For more information on compost, visit the US Composting Council website at: http://compostingcouncil.org/



Figure 2: Curb Cut located in a Bioretention Facility

To reduce erosion, a gravel pad shall be placed at each inlet point to the Bioretention Facility. The gravel should be 1- to 1.5-inch diameter in size. The gravel should overlap the curb cut opening a minimum of 6 inches. The gravel pad inside the Bioretention Facility should be flush with the finished surface at the curb cut and extend to the bottom of the slope.

In addition, place an apron of stone or concrete, a foot square or larger, inside each inlet to prevent vegetation from growing up and blocking the inlet. See Figure 3.

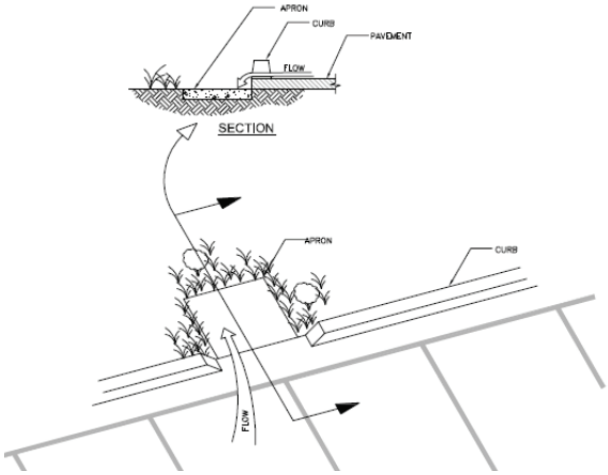


Figure 3: Apron located in a Bioretention Facility

Terracing the Landscaped Filter Basin

It is recommended that Bioretention Facilities be level. In the event the facility site slopes and lacks proper design, water would fill the lowest point of the BMP and then discharge from the basin without being treated. To ensure that the water will be held within the Bioretention Facility on sloped sites, the BMP must be terraced with nonporous check dams to provide the required storage and treatment capacity.

The terraced version of this BMP shall be used on non-flat sites with no more than a 3 percent slope. The surcharge depth cannot exceed 0.5 feet, and side slopes shall not exceed 4:1. Table 2 below shows the spacing of the check dams, and slopes shall be rounded up (i.e., 2.5 percent slope shall use 10' spacing for check dams).

Table 2: Check Dam Spacing

6" Check Dam Spacing	
Slope	**Spacing**
1%	*25'*
2%	*15'*
3%	*10'*

Roof Runoff

Roof downspouts may be directed towards Bioretention Facilities. However, the downspouts must discharge onto a concrete splash block to protect the Bioretention Facility from erosion.

Retaining Walls

It is recommended that Retaining Wall Type 1A, per Caltrans Standard B3-3 or equivalent, be constructed around the entire perimeter of the Bioretention Facility. This practice will protect the sides of the Bioretention Facility from collapsing during construction and maintenance or from high service loads adjacent to the BMP. Where such service loads would not exist adjacent to the BMP, an engineered alternative may be used if signed by a licensed civil engineer.

Side Slope Requirements

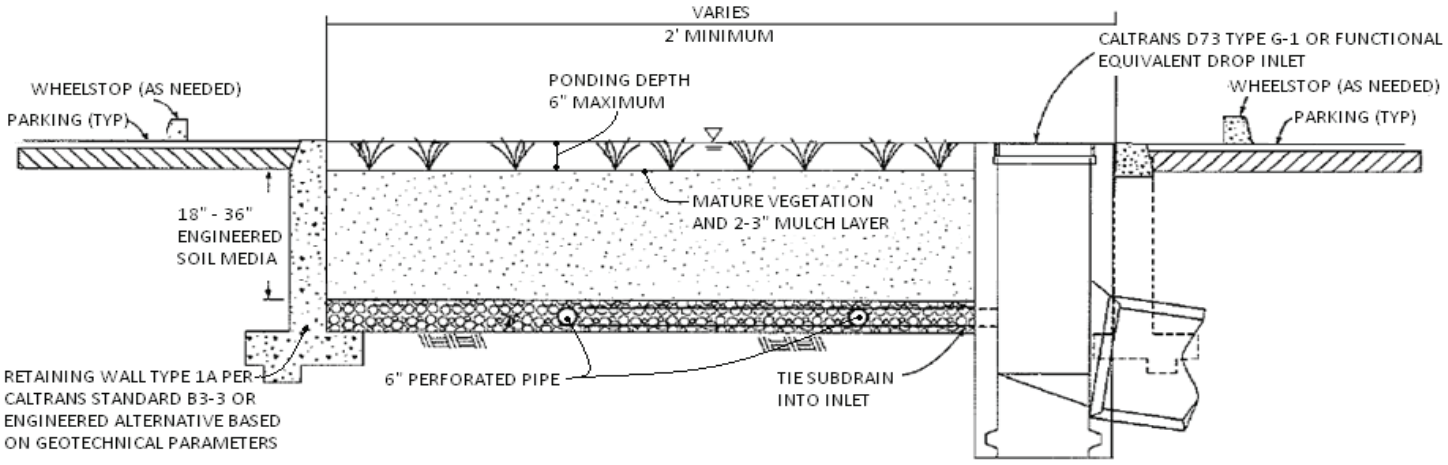
Bioretention Facilities Requiring Side Slopes

The design should assure that the Bioretention Facility does not present a tripping hazard. Bioretention Facilities proposed near pedestrian areas, such as areas parallel to parking spaces or along a walkway, must have a gentle slope to the bottom of the facility. Side slopes inside of a Bioretention Facility shall be 4:1. A typical cross section for the Bioretention Facility is shown in Figure 1.

Bioretention Facilities Not Requiring Side Slopes

Where cars park perpendicular to the Bioretention Facility, side slopes are not required. A 6-inch maximum drop may be used, and the Bioretention Facility must be planted with trees and shrubs to prevent pedestrian access. In this case, a curb is not placed around the Bioretention Facility,

but wheel stops shall be used to prevent vehicles from entering the Bioretention Facility, as shown in Figure 4.



Planter Boxes

Bioretention Facilities can also be placed above ground as planter boxes. Planter boxes must have a minimum width of 2 feet, a maximum surcharge depth of 6 inches, and no side slopes are necessary. Planter boxes must be constructed so as to ensure that the top surface of the engineered soil media will remain level. This option may be constructed of concrete, brick, stone or other stable materials that will not warp or bend. Chemically treated wood or galvanized steel, which has the ability to contaminate stormwater, should not be used. Planter boxes must be lined with an impermeable liner on all sides, including the bottom. Due to the impermeable liner, the inside bottom of the planter box shall be designed and constructed with a cross fall, directing treated flows within the subdrain layer toward the point where subdrain exits the planter box, and subdrains shall be oriented with drain holes oriented down. These provisions will help avoid excessive stagnant water within the gravel underdrain layer. Similar to the in-ground Bioretention Facility versions, this BMP benefits from healthy plants and biological activity in the root zone. Planter boxes should be planted with appropriately selected vegetation.



Figure 5: Planter Box
Source: LA Team Effort

Overflow

An overflow route is needed in the Bioretention Facility design to bypass stored runoff from storm events larger than V_{BMP} or in the event of facility or subdrain clogging. Overflow systems must connect to an acceptable discharge point, such as a downstream conveyance system as shown in Figure 1 and Figure 4. The inlet to the overflow structure shall be elevated inside the Bioretention Facility to be flush with the ponding surface for the design capture volume (V_{BMP}) as shown in Figure 4. This will allow the design capture volume to be fully treated by the Bioretention Facility, and for larger events to safely be conveyed to downstream systems. The overflow inlet shall **not** be located in the entrance of a Bioretention Facility, as shown in Figure 6.

Underdrain Gravel and Pipes

An underdrain gravel layer and pipes shall be provided in accordance with Appendix B – Underdrains.



Figure 6: Incorrect Placement of an Overflow Inlet.

Inspection and Maintenance Schedule

The Bioretention Facility area shall be inspected for erosion, dead vegetation, soggy soils, or standing water. The use of fertilizers and pesticides on the plants inside the Bioretention Facility should be minimized.

Schedule	Activity
Ongoing	• Keep adjacent landscape areas maintained. Remove clippings from landscape maintenance activities. • Remove trash and debris • Replace damaged grass and/or plants • Replace surface mulch layer as needed to maintain a 2-3 inch soil cover.
After storm events	• Inspect areas for ponding
Annually	• Inspect/clean inlets and outlets

Bioretention Facility Design Procedure

1) Enter the area tributary, A_T, to the Bioretention Facility.

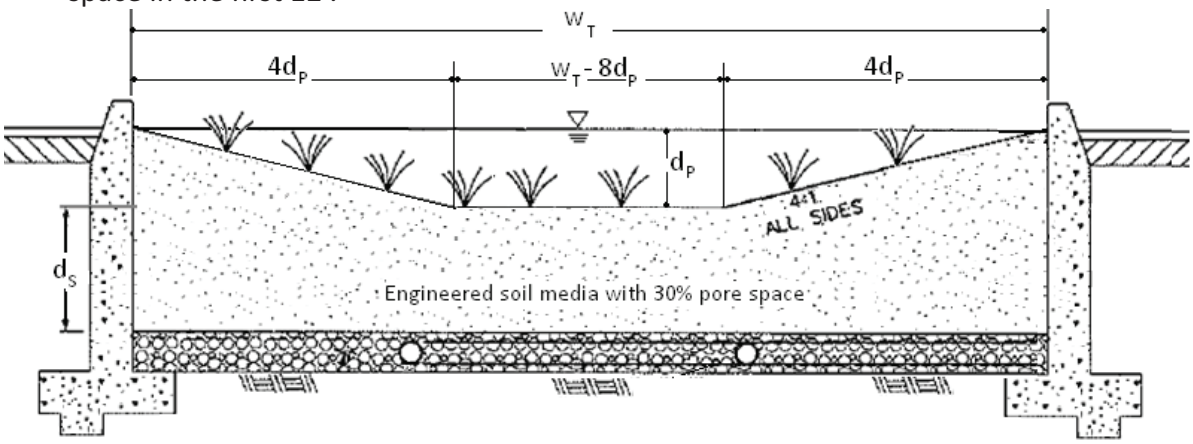
2) Enter the Design Volume, V_{BMP}, determined from Section 2.1 of this Handbook.

3) Select the type of design used. There are two types of Bioretention Facility designs: the standard design used for most project sites that include side slopes, and the modified design used when the BMP is located perpendicular to the parking spaces or with planter boxes that do not use side slopes.

4) Enter the depth of the engineered soil media, d_S. The minimum depth for the engineered soil media can be 18' in limited cases, but it is recommended to use 24' or a preferred 36' to provide an adequate root zone for the chosen plant palette. Engineered soil media deeper than 36' will only get credit for the pore space in the first 36'.

5) Enter the top width of the Bioretention Facility.

6) Calculate the total effective depth, d_E, within the Bioretention Facility. The maximum allowable pore space of the soil media is 30% while the maximum allowable pore space for the gravel layer is 40%. Gravel layer deeper than 12' will only get credit for the pore space in the first 12'.



a. For the design with side slopes the following equation shall be used to determine the total effective depth. Where, d_P is the depth of ponding within the basin.

$$d_E(\text{ft}) = \frac{0.3 \times \left[\left(w_T(\text{ft}) \times d_S(\text{ft})\right) + 4\left(d_P(\text{ft})\right)^2\right] + 0.4 \times 1(\text{ft}) + d_P(\text{ft})\left[4d_P(\text{ft}) + \left(w_T(\text{ft}) - 8d_P(\text{ft})\right)\right]}{w_T(\text{ft})}$$

This above equation can be simplified if the maximum ponding depth of 0.5' is used. The equation below is used on the worksheet to find the minimum area required for the Bioretention Facility:

$$d_E(\text{ft}) = (0.3 \times d_S(\text{ft}) + 0.4 \text{ x } 1(\text{ft})) - \left(\frac{0.7\ (\text{ft}^2)}{w_T(\text{ft})}\right) + 0.5(\text{ft})$$

b. For the design without side slopes the following equation shall be used to determine the total effective depth:

$$d_E(\text{ft}) = d_P(\text{ft}) + [(0.3) \times d_S(\text{ft}) + (0.4) \times 1(\text{ft})]$$

The equation below, using the maximum ponding depth of 0.5', is used on the worksheet to find the minimum area required for the Bioretention Facility:

$$d_E(\text{ft}) = 0.5\ (\text{ft}) + [(0.3) \times d_S(\text{ft}) + (0.4) \times 1(\text{ft})]$$

7) Calculate the minimum surface area, A_M, required for the Bioretention Facility. This does not include the curb surrounding the Bioretention Facility or side slopes.

$$A_M(\text{ft}^2) = \frac{V_{BMP}(\text{ft}^3)}{d_E\ (\text{ft})}$$

8) Enter the proposed surface area. This area shall not be less than the minimum required surface area.

9) Verify that side slopes are no steeper than 4:1 in the standard design, and are not required in the modified design.

10) Provide the diameter, minimum 6 inches, of the perforated underdrain used in the Bioretention Facility. See Appendix B for specific information regarding perforated pipes.

11) Provide the slope of the site around the Bioretention Facility, if used. The maximum slope is 3 percent for a standard design.

12) Provide the check dam spacing, if the site around the Bioretention Facility is sloped.

13) Describe the vegetation used within the Bioretention Facility.

References Used to Develop this Fact Sheet

Anderson, Dale V. "Landscaped Filter Basin Soil Requirements." Riverside, May 2010.

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United States Environmental Protection Agency. Storm Water Technology Fact Sheet Bioretention. Washington D.C, 1999.

Urban Drainage and Flood Control District. Urban Storm Drainage Criteria Manual Volume 3 - Best Management Practices. Vol. 3. Denver, 2008. 3 vols.

Urbonas, Ben R. Stormwater Sand Filter Sizing and Design: A Unit Operations Approach. Denver: Urban Drainage and Flood Control District, 2002.

Bioretention Facility - Design Procedure	BMP ID 1-D	Legend:	Required Entries / Calculated Cells

Company Name: WOODARD GROUP | Date: 2/15/2024

Designed by: PR | County/City Case No.:

Design Volume

Enter the area tributary to this feature	A_T=	1.23	acres
Enter V_{BMP} determined from Section 2.1 of this Handbook	V_{BMP}=	13	ft^3

Type of Bioretention Facility Design

○ Side slopes required (parallel to parking spaces or adjacent to walkways)

◉ No side slopes required (perpendicular to parking space or Planter Boxes)

Bioretention Facility Surface Area

Depth of Soil Filter Media Layer	d_S =	1.5	ft
Top Width of Bioretention Facility, excluding curb	w_T =	34.0	ft
Total Effective Depth, d_E			
$d_E = [(0.3) \times d_S + (0.4) \times 1] + 0.5$	d_E =	1.35	ft
Minimum Surface Area, A_m			
$A_M\,(ft^2) = \frac{V_{BMP}\,(ft^3)}{d_E\,(ft)}$	A_M =	10	ft^2
Proposed Surface Area	A=	1,511	ft^2
Minimum Required Length of Bioretention Facility, L	L =	0.3	ft

Bioretention Facility Properties

Side Slopes in Bioretention Facility	z =		:1
Diameter of Underdrain			inches
Longitudinal Slope of Site (3% maximum)			%
6" Check Dam Spacing			feet

Describe Vegetation:

Notes:

Santa Ana Watershed - BMP Design Volume, V_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name	WOODARD GROUP	Date	2/15/2024
Designed by	PR	Case No	
Company Project Number/Name	1103 ARLINGTON-MONROE		

BMP Identification

BMP NAME / ID: 1-D BIO-RETENTION

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

85th Percentile, 24-hour Rainfall Depth, from the Isohyetal Map in Handbook Appendix E

D_{85}= 0.61 inches

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type	Effective Imperivous Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Storm Depth (in)*	*Design Capture Volume, V_{BMP} (cubic feet)*	*Proposed Volume on Plans (cubic feet)*
1-A	*34,537*	*Concrete or Asphalt*	*1*	*0.89*	*30807*			
1-B	*4,740*	*Roofs*	*1*	*0.89*	*4228.1*			
1-C	*12,771*	*Ornamental Landscaping*	*0.1*	*0.11*	*1410.7*			
1-D	*1,511*	*Ornamental Landscaping*	*0.1*	*0.11*	*166.9*			
	53559		*Total*		*36612.7*	*0.61*	*1861.1*	*2,040*

Notes:

Santa Ana Watershed - BMP Design Volume, V_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name	WOODARD GROUP	Date	2/15/2024
Designed by	PR	Case No	
Company Project Number/Name	1103 ARLINGTON-MONROE		

BMP Identification

BMP NAME / ID: 2-E SELF-TREATING

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

85th Percentile, 24-hour Rainfall Depth, from the Isohyetal Map in Handbook Appendix E

D_{85}= 0.61 inches

Drainage Management Area Tabulation

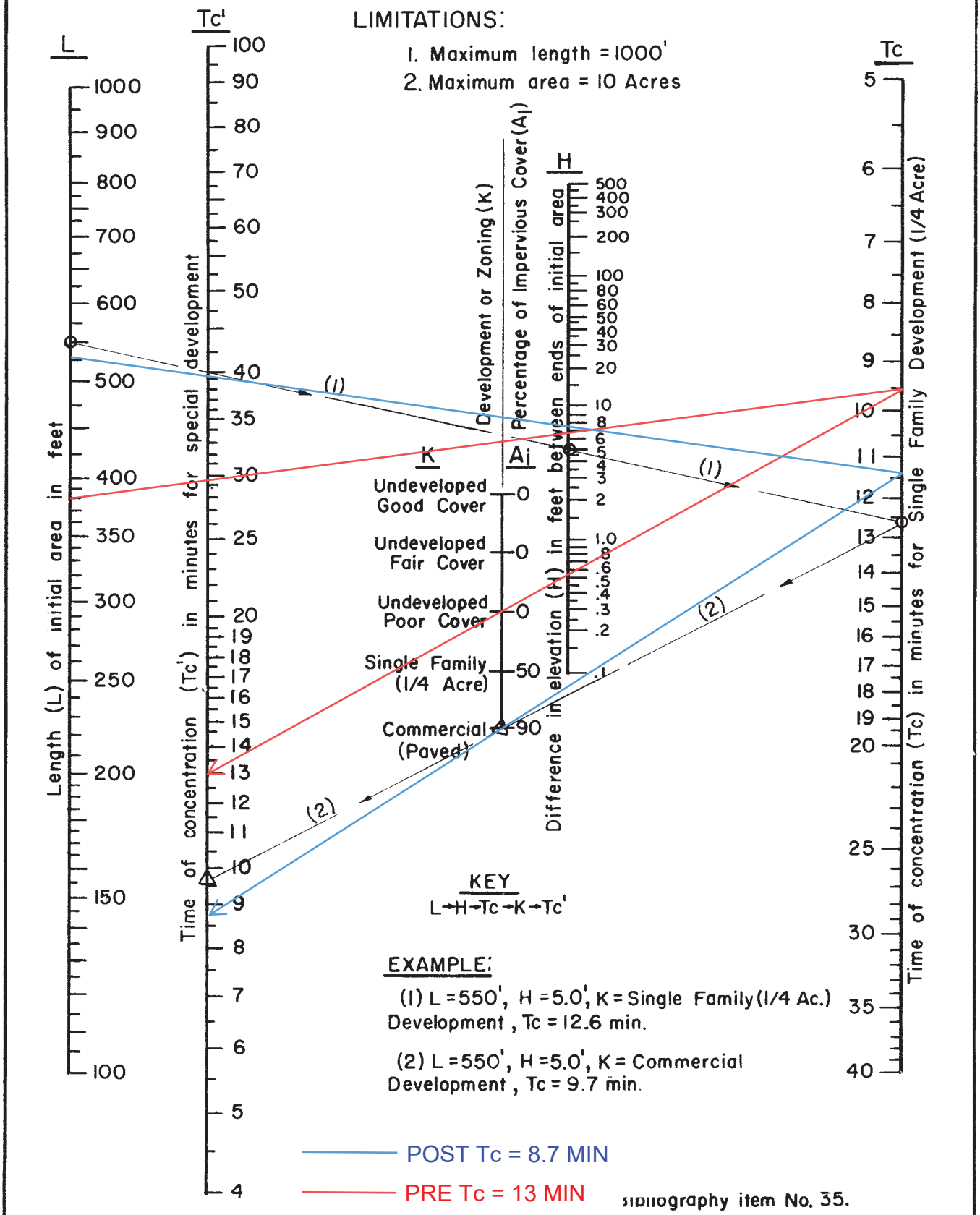
Insert additional rows if needed to accommodate all DMAs draining to the BMP

DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type	Effective Imperivous Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Storm Depth (in)*	*Design Capture Volume, V_{BMP} (cubic feet)*	*Proposed Volume on Plans (cubic feet)*
2-E	*2,316*	*Ornamental Landscaping*	*0.1*	*0.11*	*255.8*			
	2316.02		***Total***		**255.8**	**0.61**	***13***	***13***

Notes:

Appendix 7: Hydromodification

Supporting Detail Relating to Hydrologic Conditions of Concern



...bliography item No. 35.

RCFC & WCD
HYDROLOGY MANUAL

TIME OF CONCENTRATION
FOR INITIAL SUBAREA

PLATE D-3