# Appendix C
Geotechnical Investigation

# GEOTECHNICAL INVESTIGATION

Rev. October 8, 2025

Prepared For:

**NV5 Infrastructure**
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**Lake Drive Storm Drain Improvements**
**Southwest of Lake Drive – Cardiff Cove**
**Encinitas, CA**

**Project Number: 226817-0000198.16**

NV5, Inc.
15092 Avenue of Science, Suite 200
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Rev. October 8, 2025
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Subject: Geotechnical Investigation Report

Project: Lake Drive Storm Drain Improvements
Southwest of Lake Drive – Cardiff Cove
Encinitas, California

Dear Ms. O'Neal:

In accordance with your request, NV5 is pleased to present the results of its geotechnical investigation for the subject project. The purpose of this investigation was to evaluate the subsurface conditions for the proposed storm drain improvements project located in Encinitas, California. It is NV5's understanding that the project consists of the removal and replacement of approximately 2,000 linear feet of existing 48-inch Corrugated Metal Pipe (CMP), and associated appurtenances from the curb inlet along Lake Drive west through the canyon to the I-5 freeway. The existing alignment will be replaced with new pipes, retention basin and appurtenances of similar size. The new storm drain will generally follow the same alignment to preserve existing hydraulic conditions and minimize site disturbances as much as possible. The results of the geotechnical field exploration, laboratory tests, and geotechnical engineering recommendations and conclusions are presented herewith.

Based on the subsurface exploration, subsequent testing of the subsurface soils, and geotechnical engineering analyses, it was concluded that the construction of the proposed project is geotechnically feasible. This report has been prepared for the exclusive use of the client and their consultants to describe the geotechnical factors at the project site, which should be considered in the design and construction of the proposed project.

The forthcoming project specifications, in particular the earthwork/compaction sections, should be reviewed by NV5 for consistency with this report prior to the bid process in order to avoid possible conflicts, misinterpretations, and inadvertent omissions. It should also be noted, that the applicability and final evaluation of the recommendations presented herein, are contingent upon construction phase field monitoring by NV5, in consideration of the widely acknowledged importance of geotechnical consultant continuity through the various design, planning and construction stages of a project.

NV5 appreciates the opportunity to provide this geotechnical engineering service for this project and looks forward to continuing its role as your geotechnical engineering consultant.

Respectfully submitted,

**NV5, Inc.**

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# 1.0 INTRODUCTION

This report presents the results of NV5's geotechnical investigation for the proposed Lake Drive Storm Drain Improvements project located in Encinitas, California. The approximate location of the project site is shown in *Figure 1, Site Location Map* and *Figure 2, Vicinity Map*.

The purpose of this study was to evaluate the subsurface conditions and to provide geotechnical recommendations for the design and construction of replacement and/or improvements of the existing storm drain alignment and the associated appurtenances. This report summarizes the data collected and presents NV5's findings, conclusions and recommendations.

This report has been prepared for the exclusive use of the client and their consultants to describe the geotechnical factors at the project site, which should be considered in the design and construction of the proposed project. Prospective bidders should consider it only as a source of general information subject to interpretation and refinement by their own expertise and experience, particularly with regard to construction feasibility. Contract requirements as set forth by the project plans and specifications will supersede any general observations and specific recommendations presented in this report.

# 2.0 SCOPE OF SERVICES

NV5's scope of services for this project included the following tasks:

- Review of project plans, geotechnical maps and literature pertaining to the vicinity of the project.
- Performance of an onsite reconnaissance to observe the general surficial site conditions and to mark out proposed exploratory boring locations.
- Procurement of an Underground Service Alert of California (USA-CA) ticket to locate public utilities that may be in conflict with proposed exploratory borings along the project alignment.
- Coordinating with entities having an interest in the field exploration activities including NV5 civil design team, USA-CA, and the City of Encinitas.
- Performance of a subsurface investigation program which included the following:
    - Drilling, logging, and sampling of twelve (12) hand auger exploratory borings (HAB-1 through HAB-12) located along the subject alignment.
    - Performance of Dynamic Cone Penetration (DCP) testing adjacent to each hand auger boring location, to collect apparent density/consistency data.
    - Soil samples obtained from the borings were transported to NV5's laboratory for observation and testing.
- Performance of appropriate laboratory testing on selected representative bulk-disturbed samples obtained during the field exploration program to evaluate their pertinent geotechnical engineering properties.
- Geotechnical engineering assessment of general seismic conditions and geotechnical hazards (if present) affecting the area and potential impacts on the subject project.

- Geotechnical engineering evaluation of the data collected to develop geotechnical recommendations for the design and construction of the proposed project.
- Preparation of this report including reference maps and graphics, presenting NV5's findings, conclusions and geotechnical design recommendations specifically addressing the following items:
    - Evaluation of general subsurface conditions and description of types, distribution, and engineering characteristics of subsurface materials encountered.
    - Evaluation of project feasibility including excavatability, trench stability, and suitability of on-site soils for backfill.
    - Provide geotechnical recommendations concerning anticipated earthwork, temporary excavations and pipeline backfill aspects the project.

# 3.0 PROJECT AND SITE DESCRIPTION

It is NV5's understanding that the project consists of the removal of approximately 2,000 linear feet of existing 48 inch Corrugated Metal Pipe (CMP), and associated appurtenances from the curb inlet along Lake Drive west through the canyon to the I-5 freeway. The existing alignment will be replaced with new pipes and appurtenances of similar size. The new storm drain will generally follow the same alignment to preserve existing hydraulic conditions while a new retention basis will be added to support updated maximum design flows. The as-built depths of the existing alignment were not provided during preparation of the report. However, depths ranging from about 5 to 10 feet from adjacent ground surface to top-of-pipe were observed as exposed in undermined/washed-out sections of the alignment during the site reconnaissance.

The subject alignment is situated within the central drainage course of an undeveloped canyon known as "Cardiff Cove." The canyon consists of "upper" steep slopes and "lower" gentle slopes with intermediate slope gradients in-between. Vegetation within the canyon is moderately thick, primarily consisting of native chaparral shrubs, with some invasive plants/weeds and some mature trees.

# 4.0 FIELD EXPLORATION PROGRAM

Before starting the field exploration program, a field reconnaissance was conducted to observe the general surficial site conditions and to mark out the locations for the proposed exploratory borings. As required by law, Underground Service Alert of California (USA-CA) was notified of the locations of the exploratory borings, prior to excavating.

## 4.1 EXPLORATORY BORINGS

The subsurface conditions were explored on January 14th, 15th, and 18th, 2021, by drilling, logging, and sampling twelve (12) exploratory borings (labeled HAB-1 through HAB-12) using a 3-inch O.D. hand auger. The borings were drilled to maximum depths ranging from approximately 0.5 and 13 feet bgs. The approximate locations of the exploratory borings and the general site conditions (based on Google Earth satellite imagery) are displayed in *Figure 3, Geotechnical Exploration Map*.

The materials encountered in the exploratory borings were continuously observed, classified, and logged by an NV5 geologist in general accordance with the Unified Soil Classification System (USCS/ASTM D2487) and ASTM D2488. The logs of the exploratory borings are presented in *Appendix A, Exploratory Boring and DCP Test Logs*. Subsequent to logging and sampling, the exploratory borings were backfilled with soil cuttings.

### 4.2 SAMPLING METHODS

Representative bulk-disturbed samples were retrieved during exploratory drilling at selected depths appropriate to the investigation. The samples were labeled in the field and transported to NV5's laboratory for observation, evaluation, and testing. Samples collected are noted on the logs of the exploratory borings in *Appendix A*.

### 4.3 DYNAMIC CONE PENETROMETER TEST METHODS

The WILDCAT Dynamic Cone Penetrometer (DCP) testing apparatus utilizes a dedicated expendable 3.59-cm diameter cone tip attached to the bottom of a 2.75-cm diameter steel rod. The cone tip is advanced into the ground with a 35-pound, gravity driven slide-hammer and biodegradable lubricating fluids are intermittently injected through the rod to the base to reduce the skin friction of the rod during advancement. Blow counts are recorded for each 4-inch increment embedded into the ground surface and advancement is terminated at the desired target depth or when 50 blows for < 4-inch interval is achieved, whichever comes first. Blow counts are then correlated with subsurface soils encountered in the adjacent hand augered boring to determine estimates of apparent density for granular soils and consistency for fine-grained clayey soils. Logs of the test data collected are presented in *Appendix A*.

## 5.0 LABORATORY TESTING

Laboratory testing was performed on selected representative bulk-disturbed samples obtained from the exploratory borings to aid in the material classifications and to evaluate engineering properties of the materials encountered (refer to *Appendix B, Laboratory Test Results*). The following tests were performed:

- In-situ moisture content (ASTM D2216);
- Particle size sieve analyses (ASTM D6913);
- Direct shear (remolded) (ASTM D3080);
- Laboratory Compaction Characteristics (ASTM D1557); and
- Corrosivity test series; including sulfate content, chloride content, pH-value, and electrical resistivity (CTM 417, 422, and 532/643).

Testing was performed in general accordance with applicable ASTM standards and California Test Methods. A summary of the laboratory testing program and the laboratory test results are presented in *Appendix B.*

# 6.0 GEOLOGIC AND SOIL INFORMATION

## 6.1 REGIONAL GEOLOGIC SETTING

The project is located in San Diego County within the coastal section of the Peninsular Ranges geomorphic province. This province is characterized by northwest-trending mountain ranges bordered by relatively straight-sided, sediment-floored valleys. The northwest trend is also reflected in the direction of the dominant geologic structural features, which consist of northwest-southeast trending faults and fault zones associated with the San Andreas and related fault systems. Two major northwest-trending fault zones traverse the San Diego metropolitan and the inland county areas: the Rose Canyon fault zone located to the west and the Elsinore fault zone located easterly of the site. Typical stratigraphy in the Peninsular Ranges includes Mesozoic (between approximately 250 and 65 million years old) igneous intrusive and metamorphic rocks exposed in the eastern portion of the province, Cenozoic (less than 65 million years old) marine and non-marine sedimentary units overlying Mesozoic basement rocks in coastal areas and Quaternary (less than approximately 2 million years old) deposits overlying older strata in valleys and larger drainages.

## 6.2 SITE-SPECIFIC GEOLOGIC AND SOIL INFORMATION

Geologic materials encountered during the subsurface explorations include surficial topsoil and colluvial deposits (unmapped) overlying sedimentary bedrock known as the Eocene-age Torrey Sandstone (mapped as "Tt", Kennedy-Tan 2008) at relatively shallow depths. Fill soils associated with the existing storm drain alignment construction are typical in the project area and are anticipated to be encountered during the proposed construction. Although the Eocene-age Del Mar formation is mapped within the project site, it was not observed or encountered during this investigation. Typical facies associated with Del Mar formation include olive colored massive, moderately hard, well consolidated mudstone; with some interbedded zones of olive-gray to yellowish-brown, moderately hard, well consolidated clayey sandstone.

The geologic conditions of the general site area are displayed in *Figure 4, Regional Geologic Map*. Detailed information concerning the subsurface geologic units encountered and their depths are discussed below (listed from top to bottom) and presented in *Appendix A, Exploratory Boring and DCP Logs.*

- Topsoil: Topsoil materials were encountered near-surface in exploratory borings HAB-1 through HAB-6, HAB-9, and HAB-11; with an encountered thickness ranging from ½ to 1-foot. These materials consist of light brown, brown, and gray-brown; dry to moist; very loose to loose; fine- to medium-grained silty sand (SM).
- Fill: Fill materials associated with the construction of the existing storm drain alignment were encountered near-surface in exploratory borings HAB-1, HAB-8, and HAB-9; with thicknesses ranging from 4.5 to 8.5 feet. However, deeper fill soils associated with the construction of the existing pipeline should be anticipated. These materials as encountered in the borings consist of dark brown, light brown, and gray-brown; dry to moist, loose to very dense, fine- to medium-grained silty sand (SM).

The DCP test data collected indicates that apparent densities are highly variable in these materials. Given that these materials possess very little cohesive strength, special consideration should be taken when performing temporary excavations needed to replace the existing storm drain alignment. Recommendations for temporary excavations within these materials are provided in Section 8.4 of this report.

- Colluvium (Unmapped): Unmapped colluvial deposits were encountered in exploratory borings HAB-2, HAB-3, HAB-4, HAB-6, HAB-7, HAB-9, and HAB-10; with encountered depths ranging from at-surface to 1-foot bgs, and with thicknesses ranging from 1.5 to 12 feet. These materials consist of gray-brown and yellow-brown, moist, medium dense to very dense, fine- to medium-grained silty sand (SM).
- Torrey Sandstone (Tt): Sedimentary bedrock materials known as the Torrey Sandstone (Mapped as "Tt", Kennedy-Tan 2008) were encountered in all exploratory borings at encountered depths ranging from 0.5 to 12 feet bgs, and extending to the maximum depths explored. These sandstone materials consist of gray brown, moist, dense to very dense, fine- to medium-grained silty sand (SM). In addition, the "upper" portion of these materials display orange oxide staining with some localized layers of "weak" cementation.
- Del Mar Formation (Td): Although not encountered in the exploratory borings, Del Mar Formation is mapped at the project site underlying the Torrey Sandstone. This unit is defined by Kennedy-Tan 2007 as a dusky-yellowish-green, sandy, claystone interbedded with medium-gray, coarse-grained, sandstone.

## 6.3 GROUNDWATER

A "true" groundwater table was not encountered in the exploratory borings during the investigation, however, a zone of perched groundwater was encountered in boring HAB-10 at a depth of 10.5 feet bgs. It is NV5's opinion that this encountered saturated zone is a result of subsurface accumulation of runoff water that is laterally confined and perched atop relatively impermeable underlying materials.

It should be understood that groundwater levels may vary due to seasonal fluctuations and factors such as a substantial increase in surface water infiltration from landscape irrigation, agricultural activity, storage facility leaks or unusually heavy precipitation. There is uncertainty in the accuracy of short-term groundwater level measurements, particularly in fine-grained soil.

## 6.4 REGIONAL FAULT INFORMATION

The numerous faults in southern California include active, potentially active, and inactive faults. As used in this report, the definitions of fault terms are based on those developed for the *Alquist-Priolo Special Studies Zones Act of 1972* and published by the California Division of Mines and Geology (Hart and Bryant, 1997). Active faults are defined as those that have experienced surface displacement within Holocene time (approximately the last 11,000 years) and/or have been included within any of the state-designated Earthquake Fault Zones (previously known as *Alquist-Priolo Special Studies Zones*). Faults are considered potentially active if they exhibit evidence of surface displacement since

the beginning of Quaternary time (approximately two million years ago) but not since the beginning of Holocene time. Inactive faults are those that have not had surface movement since the beginning of Quaternary time.

The site is not mapped within a State-designated *Earthquake Fault Zone*, nor have active faults been mapped on the subject site. Furthermore, obvious evidence of active faulting at the site was not observed during the investigation.

The closest known active fault to the site is the Newport Inglewood-Rose Canyon connected fault zone located approximately 1.3 miles west of the site. Other important active faults that could affect the County of San Diego area and their distance to the site are included in the following **Table 1**. *Figure 5*, *Regional Fault Map* depicts the site location in relation to known active faults in the region.

**Table 1 - Distance from the Site to Major Active Faults**

| Fault Name | Distance From the Site |
|---|---|
| Newport Inglewood-Rose Canyon Connected | 1.3 miles |
| Palos Verdes Connected | 18 miles |
| Coronado Bank | 18 miles |
| Elsinore | 27 miles |
| Earthquake Valley | 41 miles |
| San Joaquin Hills | 46 miles |
| San Jacinto | 52 miles |
| South San Andreas | 70 miles |

Source: https://earthquake.usgs.gov/cfusion/hazfaults_2008_search/

# 7.0 SEISMIC AND GEOTECHNICAL HAZARDS

The findings of NV5's seismic and geotechnical hazards evaluation for the proposed project are summarized in the following sections.

## 7.1 FAULT SURFACE RUPTURE

The site is not located within an Earthquake Fault Zone delineated by the State of California for the hazard of fault surface rupture. The surface traces of any active or potentially active faults are not known to pass directly through, or to project toward the site. Therefore, the potential for surface rupture due to faulting occurring beneath the site during the design life of the proposed improvement is considered low.

## 7.2 SEISMIC SHAKING

The project alignment is located in southern California, which is considered a seismically active area, and as such the seismic hazard most likely to impact the site is ground shaking resulting from an earthquake along one of the known active faults in the region. The seismic design of the project may be performed using seismic design recommendations in accordance with the 2019 California Building Code (CBC). Recommended seismic design parameters are presented in Section 8.9 of this report.

## 7.3 LIQUEFACTION AND SEISMICALLY-INDUCED SETTLEMENT

Liquefaction and seismic (dynamic) settlement of soils can be caused by ground shaking during earthquakes. Research and historical data indicate that loose, relatively clean granular soils are susceptible to liquefaction and dynamic settlement, whereas the stability of the majority of clayey silts, silty clays and clays are not adversely affected by ground shaking. Liquefaction is generally known to occur in saturated cohesionless soils at depths shallower than approximately 50 feet. Dynamic settlement due to earthquake shaking can occur in both dry and saturated sands, and is often caused when loose to medium-dense granular soils are densified during ground shaking.

Based on information presented in the exploratory logs, much of the project alignment appears to be underlain at relatively shallow depth ( < 20 ft.) predominately by dense to very dense formational sedimentary bedrock materials, which are not considered to be susceptible to liquefaction. Appreciable groundwater was also not encountered in most subsurface explorations. Therefore, the potential for liquefaction and the associated ground deformation occurring beneath the alignment in these areas, and the potential for seismic induced settlement are considered low.

## 7.4 LANDSLIDES AND SLOPE INSTABILITY

The project alignment is located near-center of a large drainage valley with steep to gently sloping natural sidewalls. Indications of landsliding or deep-seated slope instability were not apparent at the time of this investigation. Furthermore, the relatively shallow underlying dense to very dense sandstone bedrock is generally considered to be relatively stable, and not considered susceptible to deeply seated slope instability at the currently existing slope gradients observed during the field reconnaissance.

During the field reconnaissance, signs of relatively minor and localized zones of lateral soil creep were observed in proximity to the existing storm drain alignment, and where natural slopes were previously over-steepened for the construction of the existing alignment. These “creep” type soil movements are a result of the continuous effects of both gravity and infiltration of precipitation into the surficial, relatively low cohesive materials that cover these slopes (less than 10 ft. bgs).

It should be noted that a slope stability analysis for surficial, gross, and/or global stability was not included within the scope of work for this geotechnical investigation. It is important that an NV5 geologist/engineer be present during excavation activities to observe if adverse subsurface conditions, with regards to slope instability, exist.

## 7.5 SUBSIDENCE

The project alignment is not located in an area of known ground subsidence due to the withdrawal of subsurface fluids. Accordingly, the potential for subsidence occurring at the site due to the withdrawal of oil, gas, or water is considered low.

## 7.6 TSUNAMIS, INUNDATION SEICHES, AND FLOODING

The project alignment is located at an elevation in excess of 100 feet above MSL, is about 1,300 feet from an exposed lagoon to the southwest, and about 3,100 feet inland from the Pacific Ocean. NV5’s review of the *Tsunami Hazard Area Map for San Diego County, California*, (2022) indicates that the

alignment lies outside of the mapped tsunami inundation area. Therefore, tsunamis (seismic sea waves) are not considered a hazard at the site. The site is not located near to or downslope of, any large body of water that could affect the site in the event of an earthquake-induced failure or seiche (oscillation in a body of water due to earthquake shaking). The site is located in a Zone X, minimal flood hazard area according to FEMA.

### 7.7 EXPANSIVE SOILS

Improvements including foundations and slabs in contact with earth materials with a high potential for expansion can be expected to be subject to distress based on the potential for volume change (hydro expansion and contraction) associated with highly expansive soil. Soils such as these should not be relied upon for foundation bearing. In addition, expansive soils are not typically suited for use as backfill for underground utilities.

The project alignment is underlain predominantly by granular materials. The laboratory expansion index test results and the classification of the materials encountered indicate that these materials are generally considered to have a very low expansion potential.

## 8.0 CONCLUSIONS AND DESIGN RECOMMENDATIONS

### 8.1 GENERAL

Based on the data obtained from the subsurface exploration, the associated laboratory test results, geotechnical engineering analyses, and experience with similar site conditions, it is NV5's opinion that construction/replacement of the proposed storm drain alignment and associated improvements is geotechnically feasible, provided the recommendations in this report are incorporated into the design plans and implemented during construction.

The following sections present recommendations and parameters pertaining to the geotechnical engineering design and construction of this project.

### 8.2 EARTHWORK AND GRADING

Grading using conventional cut-and-fill earthwork is anticipated for the preparation of the proposed improvement areas. Site preparation and grading should be performed in accordance with applicable grading codes, grading permits, project plans and specifications and the recommendations provided herein. Grading observation and testing will be required by NV5 in order to certify fills in conformance with grading permit requirements. Site grading and other miscellaneous construction should be performed in accordance with the following recommendations and the *Typical Earthwork Guidelines* provided in ***Appendix D, Typical Earthwork Guidelines***. In the event of conflict, the recommendations presented herein supersede those in ***Appendix D, Typical Earthwork Guidelines.***

- Clearing and Grubbing - Prior to grading, the project area should be cleared of significant surface vegetation, demolition rubble, trash, pavement, debris, etc. Any buried organic debris or other unsuitable contaminated material encountered during subsequent excavation and grading work should also be removed. Removed material and debris should be properly disposed of offsite. Holes resulting from removal of buried obstruction which extend below

finished site grades should be filled with properly compacted soils. Any utilities within the footprint of planned structural improvements should be appropriately abandoned.

- Site Grading – Areas to receive surface improvements or fill soils should be treated as follows:

  - Excavatability – Based on the subsurface exploration, it is anticipated that the on-site soils can be excavated by modern conventional heavy-duty excavating equipment in good operating condition.

  - Material for Fills – Fill materials should be free of deleterious or oversized materials. Any rocks with a maximum dimension greater than 4 inches should be screened and removed, and rocks with a maximum dimension greater than 3 inches should not be placed in the upper 3 feet of the building pad or in utility trenches. Fine grained, plastic soils should not be used for foundation support. The removed soils should be mixed thoroughly, prior to placement, to achieve relevant uniformity and consistence for the planned engineered fill.

    As noted, laboratory testing of onsite soils indicated low expansion potential. Onsite soil materials are considered suitable for reuse as compacted fills as long as they meet project specifications and have an Expansive Index of less than 50. Since site grading may redistribute the on-site soils, potential expansive soil properties should be verified at the completion of rough grading.

    It is noted that variability in soil conditions may occur between boring locations, and further observation and testing of near surface soils may be required if differing conditions are encountered during construction. If highly expansive soils are encountered during site grading and excavation, they would not be suitable for use as structural fill or trench backfill.

  - Import Soils – Import soils should be sampled and tested for suitability by NV5 prior to delivery to the site. Imported fill materials should consist of granular soils free from vegetation, debris, or rocks larger than 3 inches in maximum dimension, and the tested Expansion Index value should not exceed 20 (i.e., very low expansion potential). Additionally, import materials should not be considered corrosive as defined by Caltrans (2022) corrosion guidelines and ACI 318. To reduce the potential of importing contaminated materials to the site, prior to delivery, soil materials obtained from off-site sources should be sampled and tested in accordance with standard practice (Department of Toxic Substances Control [DTSC], 2001). Soils that exhibit a known risk to human health, the environment, or both, should not be imported to the site.

  - Structural Fill Placement - Areas to receive fill and/or surface improvements should be scarified to a minimum depth of 6 inches, brought to near-optimum moisture conditions, and compacted to at least 90 percent relative compaction, based on laboratory standard ASTM D1557. Fill soils should be brought to at least 1 percent over optimum moisture conditions and compacted in uniform lifts to at least 90 percent relative compaction (ASTM D1557). The optimum lift thickness to produce a uniformly compacted fill will depend on the size and type of construction equipment used. In general, fill should be

placed in uniform lifts not exceeding 8 inches in loose thickness. Placement and compaction of fill should be observed and tested by the geotechnical consultant.

## 8.3 EXCAVATIBILITY

Based on the results of the subsurface explorations and testing, and experience with similar materials in this area of San Diego County, it is NV5's opinion that excavations in the encountered materials can likely be accomplished by conventional heavy-duty excavating equipment in good operating condition. However, it should be noted that the sedimentary bedrock encountered may have locally cemented zones that were not encountered during the subsurface investigation, which may present excavation difficulties. Heavy ripping, jackhammering, rock splitting or other methods may be necessary to facilitate excavation of cemented zones. In addition, due to soils with low cohesion and perched groundwater or seepage conditions, caving of soils should be anticipated in excavations. The contractor should consider appropriate measures to mitigate caving.

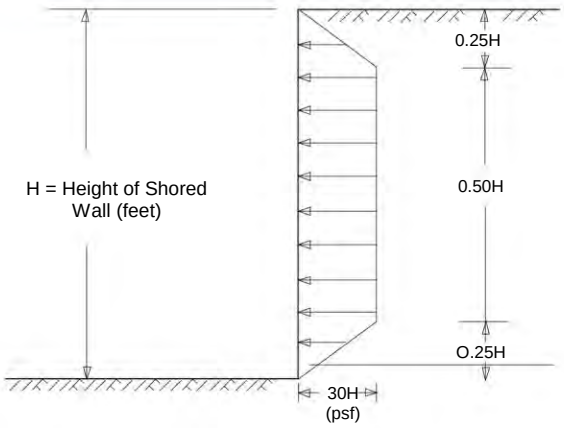
## 8.4 TEMPORARY EXCAVATIONS AND SHORING

Temporary, unsurcharged, excavation walls may be sloped back at an inclination no steeper than 1.5:1(H:V) within fill, topsoil, and colluvium and 1:1 in Torrey Sandstone. Utility trench excavations should be shored in accordance with guidelines and regulations set forth by Cal-OSHA. Temporary, shallow excavations with vertical side slopes less than 4 feet high will generally be stable, although there is a potential for sloughing. In these soil types, vertical excavations greater than 4 feet high should not be attempted without proper shoring to mitigate instabilities.

For planning purposes, the fill, topsoil, and colluvium may be considered a Type C soil and the Torrey sandstone bedrock may be considered a Type B soil, as defined by the current Cal-OSHA soil classification. Stockpiled (excavated) materials should be placed no closer to the edge of a trench excavation than a distance defined by a line drawn upward from the bottom of the trench at an inclination of 1:1 (H:V), but no closer than 4 feet. All trench excavations should be made in accordance with Cal-OSHA requirements.

Temporary shoring may be accomplished by several methods including: hydraulic shores and trench plates; trench boxes; and soldier piles and lagging. For vertical excavations less than about 15 feet in height, cantilevered shoring may be used. Cantilevered shoring may also be used for deeper excavations; however, the total deflection at the top of the wall should not exceed half-inch. Therefore, shoring of excavations deeper than about 15 feet may need to be accomplished with the aid of tied back earth anchors. The excavation support system should be designed to resist lateral earth pressures of the soil and hydrostatic pressures. Preliminary design of cantilevered temporary shoring, a triangular distribution of lateral earth pressure may be used. It may be assumed that the subgrade soils, with a level surface behind the cantilevered shoring, will exert an equivalent fluid pressure of 40 pcf for static condition. For seismic loads plus static loads, an equivalent fluid pressure of 60 pcf may be assumed. The resultant of seismic and static forces acts at H/3 from the bottom of the excavation. Hydrostatic pressure should also be considered where applicable.

Tied-back or braced shoring should be designed to resist a trapezoidal distribution of lateral earth pressure. The recommended pressure distribution, for the case where the grade is level behind the shoring, is illustrated in the following diagram with the pressure equal to 30H in psf for static condition, where H is the height of the shored wall in feet.




Any surcharge (live, including traffic, or dead load) located within a 1:1 (H:V) plane drawn upward from the base of the shored excavation should be added to the lateral earth pressures. The vertical loads imposed by existing structures, if any, should be determined by the structural engineer. The lateral load contribution of a uniform surcharge load located across the 1:1 (H:V) zone behind the excavation may be calculated in accordance with *Figure 6, Lateral Surcharge Loads*. For construction traffic, a 2-ft equivalent soil surcharge is recommended to be included in design. Passive pressure of 300 psf per foot of depth may be used in design.

The temporary shoring recommendations provided in this report are preliminary in nature. The actual shoring design should be provided by the contractor's registered civil engineer in the State of California experienced in the design and construction of shoring under similar conditions. Once the final excavation and shoring plans are complete, the plans and the design should be reviewed by NV5 for conformance with the design intent and geotechnical recommendations. The shoring system should further satisfy requirements of Cal-OSHA.

## 8.5 DEWATERING

Perched groundwater was encountered in the lower most exploratory boring (HAB-10) at a depth of 10.5 feet bgs, and at an approximate elevation of 97.5 feet above MSL. This perched groundwater is subject to fluctuations in response to a number of factors (for details refer to Section 6.3 of this report).

In addition, given the sites underlying granular and permeable soils encountered, and the known blockage and overtopping of the existing storm drain line, the existing fill material in close proximity to the storm drain alignment has potential to be saturated upon excavation activities. Zones of water seepage could exist during project construction and should be anticipated.

If necessary, dewatering may be achieved by means of excavating a series of shallow trenches directed by gradient (i.e., gravity) to sumps with pumps. The actual means and methods of any dewatering scheme should be established by a contractor with local experience. It is important to note that temporary dewatering, if necessary, will require a permit and plan that complies with RWQCB regulations. If excessive water is encountered, NV5 should be contacted to provide additional recommendations for temporary construction dewatering. Based on the subsurface exploration the onsite soils maybe considered to be moderately permeable.

## 8.6 TRENCH BOTTOM AND BASIN EXCAVATION STABILITY

The bottom of on-site excavations may expose colluvium and/or Torrey Sandstone bedrock. These materials possess an observed/tested minimum density of medium dense to very dense, display adequate soil bearing properties, and should provide a suitable base for construction of pipelines provided design is based upon the recommendations provided herein. However, fill materials encountered during the subsurface investigation displayed variable densities. Any soft/loose/wet materials encountered during construction are not considered to be suitable for trench bottoms and should be replaced with more suitable bearing material.

It is understood that the new planned retention basin will have a 1:1 slope on one side of the basin. This slope will require engineered stabilization/protection methods beyond soil compaction. The contractor should design and construct a stabilized slope using a mechanical means such as tiebacks or soil nails with concrete/shotcrete facing or chemical stabilizing treatment of the slope soil under the design of a professional engineer experienced with this type of work.

If trench bottom soils become wet or saturated, they may be prone to settlement due to construction activities such as placement of overlying proposed storm drain pipe and backfill material. Buried improvements underlain by these soils could also be damaged or subjected to unacceptable settlement due to subsidence of these soils. If wet or unusually soft conditions are encountered in the trench bottom, the bottom of the excavations will need to be stabilized. A typical stabilization method includes overexcavation of the soft or saturated soil and replacement with properly compacted fill, gravel or lean concrete to form a "mat" or stable working surface in the bottom of the excavation. There are other acceptable methods that can be implemented to mitigate the presence of compressible soils or unstable trench bottom conditions, and specific recommendations for a particular alternative can be discussed based on the actual construction techniques and conditions encountered.

Fill soil placed in bottom of trenches should be compacted to 90 percent of maximum dry density and at ±2 percent of the optimum moisture content based on ASTM D1557, unless otherwise directed by the geotechnical engineer.

## 8.7 PIPE BEDDING AND MODULUS OF SOIL REACTION (E')

It is recommended that bedding materials be placed at the base of the trench and below the base of the proposed storm drain pipe to provide uniform support and protection. Special care should be taken by the contractor during placement of the pipe bedding so that uniform contact between the bedding and the base of the pipe is attained. Bedding should be placed in loose lift thicknesses not exceeding 8 inches (maximum compacted thickness of 6 inches) and compacted by mechanical means to attain a relative compaction of 90 percent based on ASTM D1557. There should be sufficient clearance along the sides of the pipe to allow for compaction equipment. The pipe bedding shall be compacted under the haunches and alongside the pipe. For the design of thrust blocks, please refer to *Figure 7, Thrust Block Detail.* Mechanical compaction and hand tamping should be performed carefully as to not damage the pipe.

The modulus of soil reaction (E') is used to characterize the stiffness of soil backfill placed at the sides of buried flexible pipes for the purpose of evaluating deflection caused by the weight of the backfill over the pipe (Hartley and Duncan, 1987). A soil reaction modulus of 1,000 pounds per square inch (psi) may be used for an excavation depth of up to approximately 5 feet when backfilled with granular

soil compacted to a relative compaction of 90 percent as evaluated by the ASTM D 1557. A soil reaction modulus of 1,400 psi may be used for trenches deeper than 5 feet.

## 8.8 BACKFILL PLACEMENT AND COMPACTION

On-site, relatively clean sandy soils (clayey sands and silty sands) encountered should generally be suitable for re-use as backfill material above the pipe bedding zone, provided they are free of deleterious and oversized materials, and brought to near-optimum moisture conditions (either by wetting or drying as-necessary). Fill materials should not contain rocks and lumps with a maximum dimension greater than 3 inches and not more than approximately 30 percent larger than ¾-inch.

Unless otherwise directed by the geotechnical engineer, trench backfill should be compacted in uniform lifts (not exceeding 8 inches in loose lift thickness, 6 inches maximum compacted) by mechanical means to 90 percent relative compaction (ASTM D1557) and within ±2 percent of optimum moisture content.

Imported material for use as trench backfill should consist of granular, non-expansive soil with an Expansion Index (EI) of 20 or less and should not contain any contaminated soil, debris, organic matter, or other deleterious materials. In addition, import material should not contain rock or lumps larger than 3 inches (in greatest dimension).The Sand Equivalent (SE) of the imported material shall be 30 or greater. Additionally, import materials should not be considered corrosive as defined by Caltrans (2018) corrosion guidelines and ACI 318. Import material should be evaluated for suitability by the geotechnical consultant prior to transport to the site.

## 8.9 SEISMIC DESIGN PARAMETERS

Preliminary seismic parameters were developed for the project site based on the 2019 California Building Code (CBC) and ASCE 7-16 guidance document. Using the Structural Engineers Association of California's U.S. Seismic Design Maps Online Calculator (https://seismicmaps.org/), based on the following site "mid-point" coordinates: Latitude = 33.017678 degrees, and Longitude = -117.268173 degrees. The earthquake hazard level of the Maximum Considered Earthquake (MCE) is defined in ASCE 7-16 as the ground motion having a probability of exceedance of 2 percent in 50 years.

The preliminary seismic design parameters for the project site are presented in **Table 2** below. NV5 should be contacted to provide revisions to these parameters if other codes are specified.

Table 2 - Recommended 2019 CBC Seismic Design Parameters

| Design Parameter | Recommended Value | Reference |
|---|---|---|
| Site Class | C | CBC app 1613.3.2 |
| Mapped Spectral Accelerations for short periods, $S_S$ | 1.164g | CBC Section 1613.2.1 |
| Mapped Spectral Accelerations for 1-sec period, $S_1$ | 0.415g | CBC Section 1613.2.1 |
| Short-Period Site Coefficient, $F_a$ | 1.2 | CBC Table 1613.3.1 |
| Long-Period Site Coefficient, $F_v$ | 1.5 | CBC Table 1613.3.1 |
| (1) $MCE_R$ (5% damped) spectral response acceleration for short periods adjusted for site class, $S_{MS}$ | 1.397g | CBC Section 1613.3.3 |
| (1) $MCE_R$ (5% damped) spectral response acceleration at 1-second period adjusted for site class, $S_{M1}$ | 0.622 | CBC Section 1613.3.3 |
| Design spectral response acceleration (5% damped) at short periods, $S_{DS}$ | 0.931g | CBC Section 1613.3.4 |
| Design spectral response acceleration (5% damped) at 1-second period, $S_{D1}$ | 0.415 | CBC Section 1613.3.4 |
| Seismic Design Risk Category | I | CBC Section 1613.3.5 |
| (2) $MCE_G$ Peak Ground Acceleration adjusted for site class effects, $PGA_M$ | 0.624g | ASCE 7-16 Section 11.8.3 |

(1) $MCE_R$ = Risk-adjusted Maximum Considered Earthquake
(2) $MCE_G$ = Geometric-mean Maximum Considered Earthquake

## 8.10 SOIL CORROSION

The corrosion potential of the on-site materials to steel and buried concrete, at select boring locations and depths, was evaluated. Laboratory testing was performed on selected soil samples to evaluate pH, minimum resistivity, and chloride and soluble sulfate content. **Table 3** below presents the results of the corrosivity testing. General recommendations to address the corrosion potential of the on-site soils are provided below. If additional recommendations are desired, we recommend that a corrosion specialist be consulted.

Table 3 - Corrosivity Test Results

| Location / Depth (ft.) | USCS Classification | pH | Minimum Resistivity (Ohm-cm) | Water Soluble Sulfates (ppm) | Water Soluble Chlorides (ppm) |
|---|---|---|---|---|---|
| HAB–1 @ 2 – 5 | Silty SAND (SM) | 7.0 | 640 | 81 | 480 |
| HAB–8 @ 5 – 11.5 | Silty SAND (SM) | 7.2 | 2200 | 39 | 75 |

Caltrans Corrosion Guidelines dated May 2021 considers a site to be corrosive if one or more of the following conditions exist for the representative soil samples taken at the site:

> *Chloride concentration is 500 ppm or greater, sulfate concentration is 1500 ppm or greater, or if pH is 5.5 or less*

Minimum resistivity in soil or water is considered an indicator parameter and is not used to define a corrosive soil environment. Caltrans guidelines state that a "minimum resistivity value for soil and/or water less than 1,500 Ohm-cm indicates the presence of high quantities of soluble salts and a higher propensity for corrosion". A significant presence of chloride ions can lead to corrosion of steel reinforcement in concrete and steel structures by breaking down the normally present protective layer of present on the steel surface. A significant presence of sulfate ions may also lead to accelerated corrosion of steel reinforcement and are also potentially deleterious to concrete (by reacting with lime). The presence of high acidity (pH of 5.5. or less) soil or water can react with the lime resulting in associated leaching of concrete (which makes it more porous and weaker). Acidic conditions often cause discoloration (yellowish or rust color). Based on experience and the Caltrans Corrosion Guidelines, test results indicate that site soils would be considered to be corrosive.

As indicated in the 2006 edition (second edition) of "Corrosion Basics - An Introduction", a general guideline for soil resistivity and corrosion-severity ratings is presented in **Table 4** below.

Table 4 – Soil Resistivity Versus Corrosivity

| Soil Resistivity | Corrosivity |
|---|---|
| <1,000 ohm-cm | Extremely Corrosive |
| 1,000 to 3,000 ohm-cm | Highly Corrosive |
| 3,000 to 5,000 ohm-cm | Corrosive |
| 5,000 to 10,000 ohm-cm | Moderately Corrosive |
| 10,000 to 20,000 ohm-cm | Mildly Corrosive |
| >20,000 ohm-cm | Essentially Noncorrosive |

Soil resistivity is not the only parameter affecting the risk of corrosion damage; and a high soil resistivity will not guarantee the absence of serious corrosion. For example, the American Water Works Association (AWWA) has developed a numerical soil-corrosivity scale, applicable to cast-iron alloys. The soil resistivity test results suggest the potential for soils to be extremely corrosive to highly corrosive to ferrous pipes.

Any imported soils should be evaluated for corrosion characteristics if they will be in contact with buried or at-grade structures and appropriate mitigation measures should be included in the structure design. It is recommended that a corrosion specialist be contacted to determine if mitigation measures are necessary.

# 9.0 DESIGN REVIEW AND CONSTRUCTION MONITORING

Geotechnical review of plans and specifications is of paramount importance in engineering practice. The poor performance of many pipelines has been attributed to inadequate geotechnical review of construction documents. Additionally, observation and testing of the backfill, subgrade and base will be important to the performance of the proposed improvements. The following sections present NV5's recommendations relative to the review of construction documents and the monitoring of construction activities.

## 9.1 CONSTRUCTION MONITORING

Site preparation, removal of unsuitable soils, assessment of on-site soils for use as backfill, assessment of imported fill materials, backfill placement, and other earthwork operations should be observed and tested. The substrata exposed during the construction may differ from that encountered in the exploratory test borings. Continuous observation by a representative of NV5 during construction allows for evaluation of the soil/rock conditions as they are encountered and allows the opportunity to recommend appropriate revisions where necessary.

# 10.0 LIMITATIONS

The recommendations and opinions expressed in this report are based on NV5's review of background documents and on information developed during this study. It should be noted that this study did not evaluate the possible presence of hazardous materials on any portion of the site.

Due to the limited nature of the field explorations, conditions not observed and described in this report may be present on the site. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface evaluation and laboratory testing can be performed upon request. It should be understood that conditions different from those anticipated in this report may be encountered during the proposed structure construction operations.

Site conditions, including ground-water level, can change with time as a result of natural processes or the activities of man at the subject site or at nearby sites. Changes to the applicable laws, regulations, codes, and standards of practice may occur as a result of government action or the broadening of knowledge. The findings of this report may, therefore, be invalidated over time, in part or in whole, by changes over which NV5 has no control.

NV5's recommendations for this site are, to a high degree, dependent upon appropriate quality control of subgrade preparation, fill/backfill placement, etc. Accordingly, the recommendations are made contingent upon the opportunity for NV5 to observe grading operations and foundation excavations for the proposed construction. If parties other than NV5 are engaged to provide such services, such parties must be notified that they will be required to assume complete responsibility as the geotechnical engineer of record for the geotechnical phase of the project by concurring with the recommendations in this report and/or by providing alternative recommendations.

This document is intended to be used only in its entirety. No portion of the document, by itself, is designed to completely represent any aspect of the project described herein. NV5 should be contacted if the reader requires additional information or has questions regarding the content, interpretations presented, or completeness of this document.

NV5 has endeavored to perform this study using the degree of care and skill ordinarily exercised under similar circumstances by reputable geotechnical professionals with experience in this area in similar soil/rock conditions. No other warranty, either expressed or implied, is made as to the conclusions and recommendations contained in this study.

## 11.0 SELECTED REFERENCES


American Concrete Institute (ACI), 2014, ACI 318 Building Code Requirements for Structural Concrete and Commentary.

ASTM, Soil and Rock: American Society for Testing and Materials: vol. 4.08 for ASTM test methods D-420 to D-4914; and vol. 4.09 for ASTM test methods D-4943 to highest number.

CBC, 2019, California Building Code.

California Department of Conservation, California Geological Survey, 2022. State of California, Tsunami Hazard Area Map for San Diego County, California, October 7.

California Department of Transportation, 2021, Corrosion Guidelines. Version 3.2, dated May.

FEMA, Flood Map Service Center, https://msc.fema.gov/portal/, panel number 06073C1044H, effective December 20, 2019.

Hartley, J.D., and Duncan, J.M., 1987, E' and Its Variation with Depth: American Society of Civil Engineers (ASCE), Journal of Transportation Engineering, Vol. 113, No. 5: dated September.

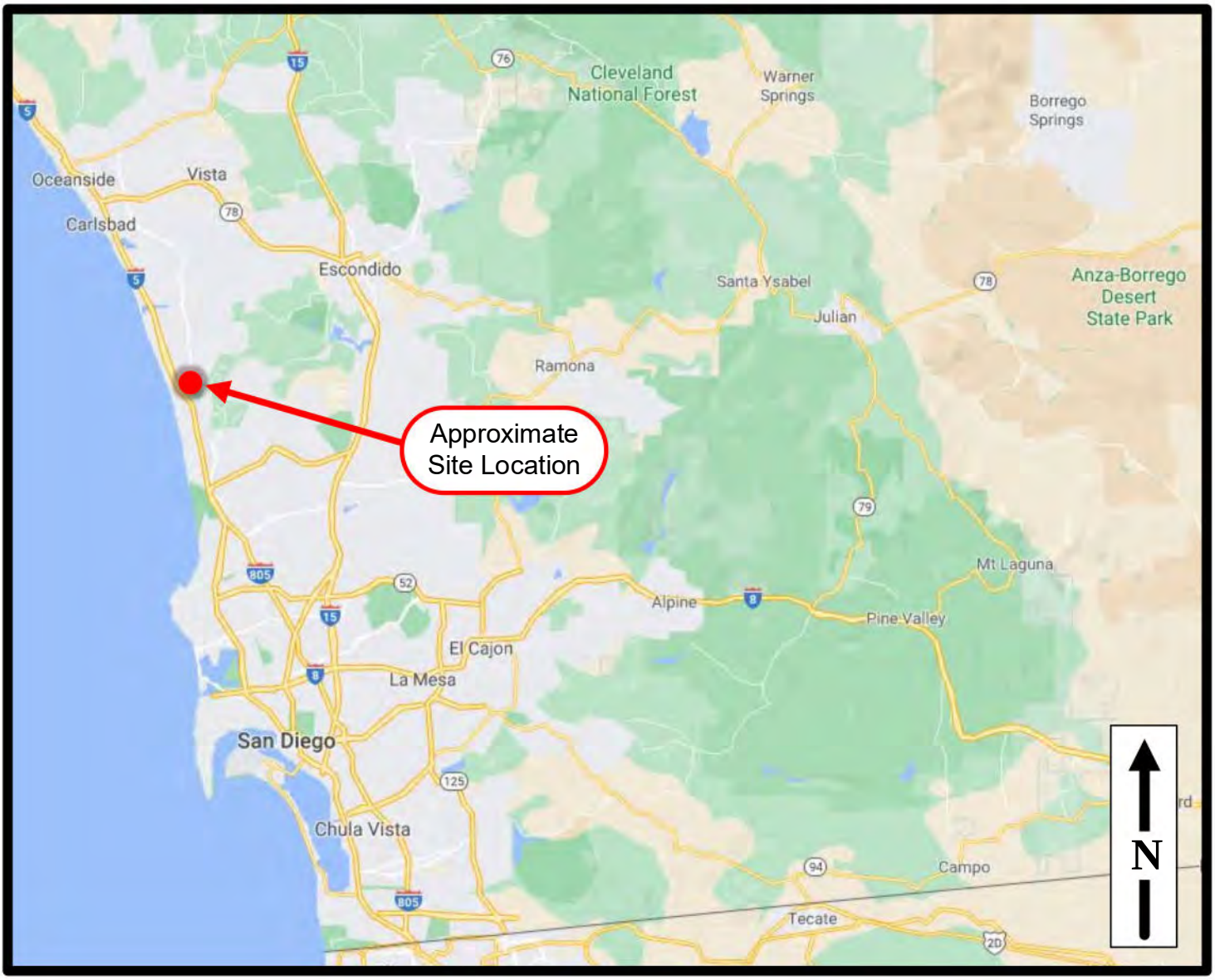
Kennedy, M.P., and Tan, S.S., 2007, Geologic Map of the Oceanside 30' x 60' Quadrangle, California.

United States Geological Survey (USGS), 2022, Interactive U.S. Fault Map, https://usgs.gov/programs/earthquake-hazards/faults

USGS, 2025, Earthquake Catalog, https://usgs.gov/earthquakes/search/

USGS Seismic Ground Motion Design Parameter Tool, https://seismicmaps.org/

# FIGURES




NOTE: Map Not to Scale.

Reference: Google Maps 2021

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Project No: **226817-0000198.16**
Drafted By: **A. Hespeler**
Date: **April 2021**

**SITE LOCATION MAP**
Lake Drive Storm Drain Improvements
Southwest of Lake Drive – Cardiff Cove
Encinitas, CA

**FIGURE 1**

Approximate Scale
1 inch = 600 feet

(When printed on 8.5" by 11'' paper.)

Reference: Nearmap.com Imagery 2020

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**VICINITY MAP**
Lake Drive Storm Drain Improvements
Southwest of Lake Drive – Cardiff Cove
Encinitas, CA

**FIGURE 2**

# LEGEND

**HAB-12 / DCP-12** — Approximate location of exploratory hand auger boring and DCP test.

Approximate location of existing storm drain alignment to be removed and replaced.

0 — 400-ft — 800-ft — 1200-ft — 1600-ft

**Approximate Scale:**
**1" = 200'**
(When printed on 11" by 17" paper.)

Reference: Nearmap.com Imagery 2020

NOTE: This map is intended for geotechnical information only. All locations and dimensions are approximate. Actual dimensions and locations of the existing storm drain alignment should be obtained from the approved project plans.


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**GEOTECHNICAL EXPLORATION MAP**
Lake Drive Storm Drain Improvements
Southwest of Lake Drive – Cardiff Cove
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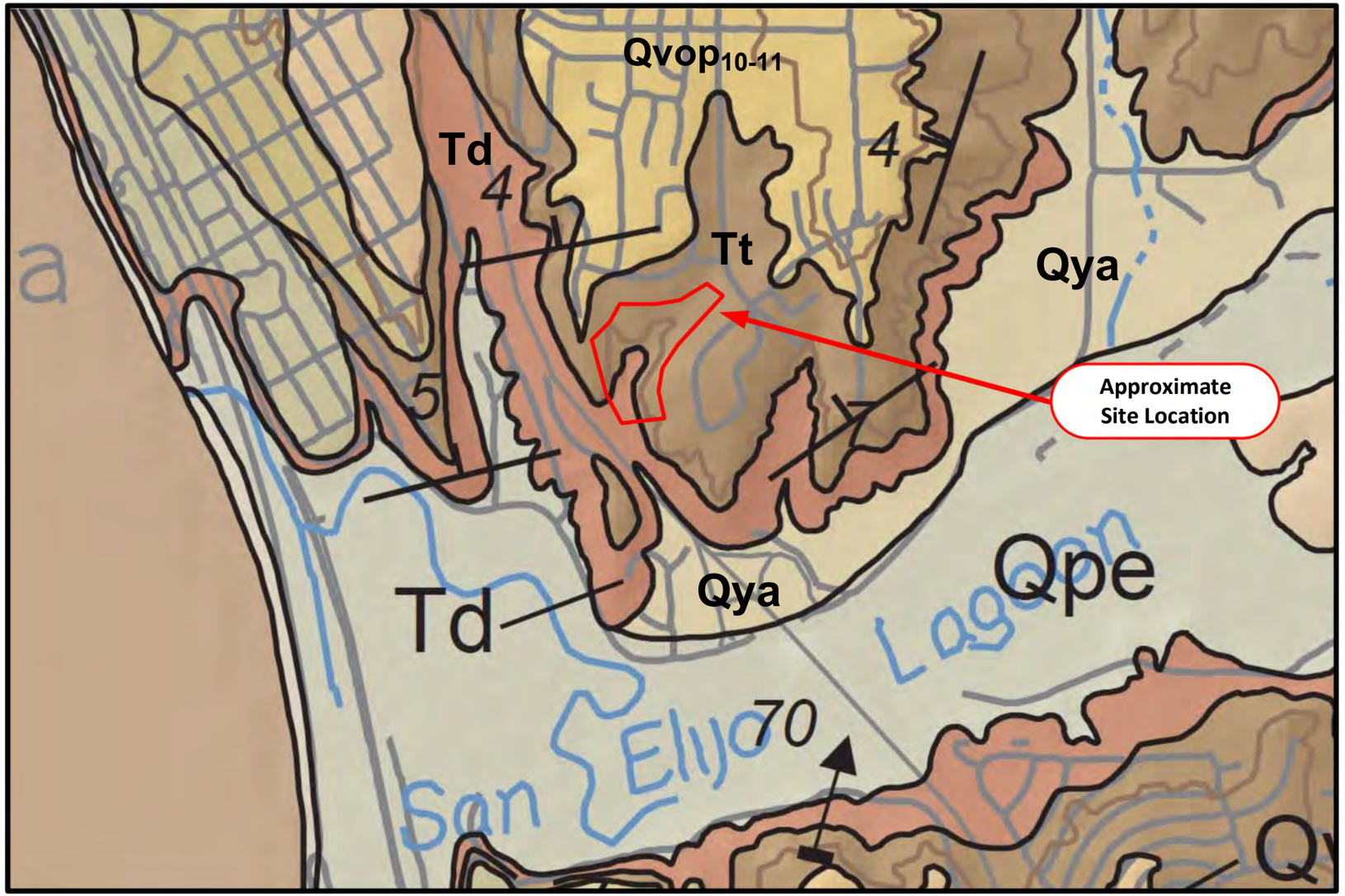
**FIGURE 3**




0 .5 1 2 Miles

## Description of Map Units

**Qvop10-11** Units 10-11
Very old paralic deposits, undivided (middle to early Pleistocene)

**Tt** Torrey Sandstone (middle Eocene)

**Td** Delmar Formation (middle Eocene)

EXCERPT FROM THE "GEOLOGIC MAP OF THE OCEANSIDE 30'x60' QUADRANGLE, CALIFORNIA"
By
M. Kennedy and S. Tan, 2007

N

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**REGIONAL GEOLOGIC MAP**
Lake Drive Storm Drain Improvements
Southwest of Lake Drive – Cardiff Cove
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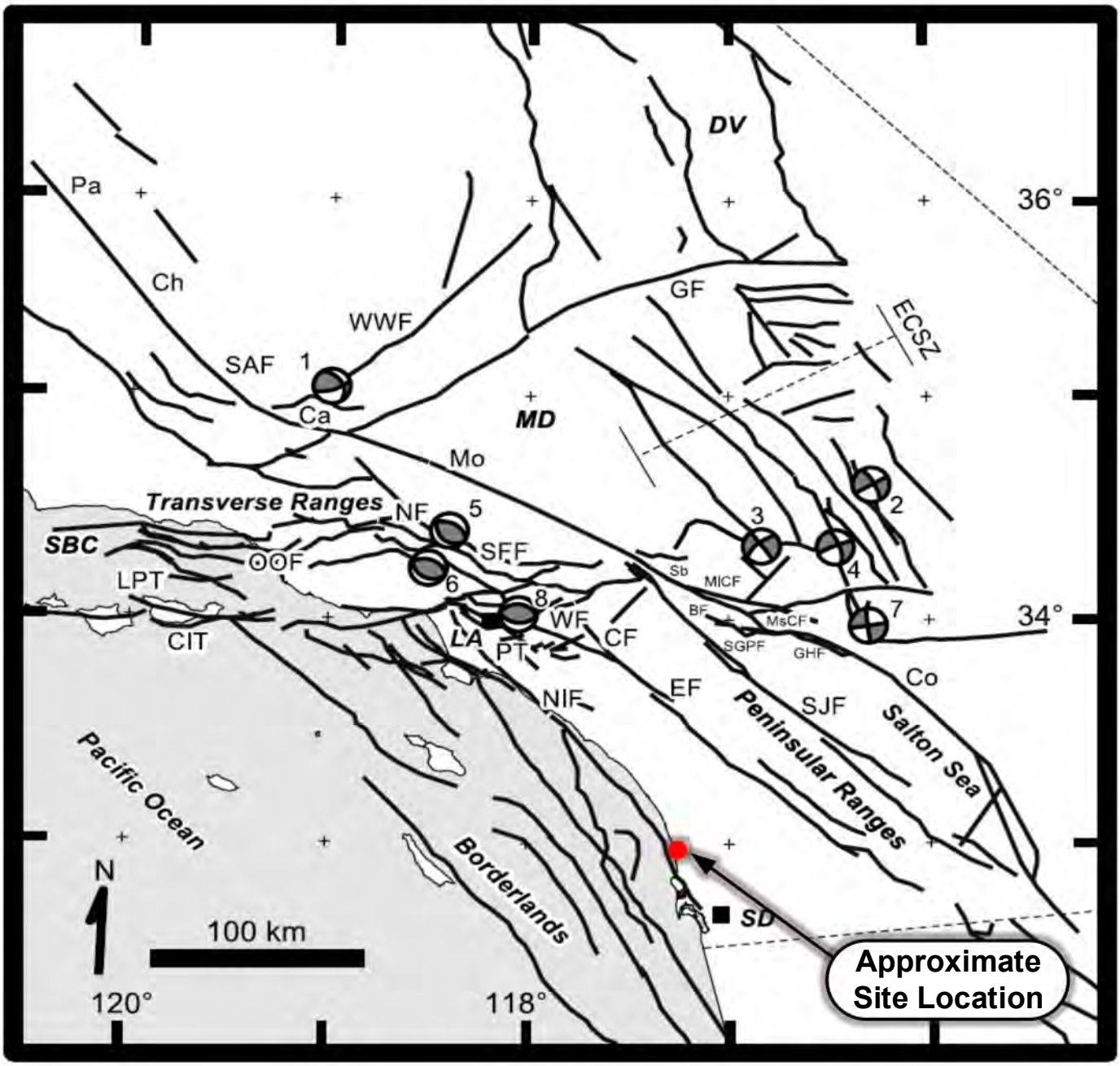
**FIGURE 4**




Map of southern California showing the geographic regions, faults and focal mechanisms of the more significant earthquakes. **Regions:** Death Valley, DV; Mojave Desert MD; Los Angeles, LA; Santa Barbara Channel, SBC; and San Diego, SD. **Indicated Faults:** Banning fault, BF; Channel Island thrust, CIT; Chino fault, CF; Eastern California Shear Zone, ECSZ; Elsinore fault, EF; Garlock fault, GF; Garnet Hill fault, GHF; Lower Pitas Point thrust, LPT; Mill Creek fault, MICF; Mission Creek fault, MsCF; Northridge fault, NF; Newport Inglewood fault, NIF; offshore Oak Ridge fault, OOF; Puente Hills thrust, PT; San Andreas fault (sections: Parkfield, Pa; Cholame, Ch; Carrizo; Ca; Mojave, Mo; San Bernardino, Sb; and Coachella, Co); San Fernando fault, SFF; San Gorgonio Pass fault, SGPF; San Jacinto fault, SJF; Whittier fault, WF; and White Wolf fault, WWF. **Earthquake Focal Mechanisms:** 1952 Kern County, 1; 1999 Hector Mine, 2; 1992 Big Bear, 3; 1992 Landers, 4; 1971 San Fernando, 5; 1994 Northridge, 6; 1992 Joshua Tree, 7; and 1987 Whittier Narrows, 8.

Reference: Plesch, Anndreas et. al., 2007, Community Fault Model (CFM) for Southern California; in the *Bulletin of the Seismological Society of America*, Vol. 97, No. 6. pp. 1793-1802, dated December.

NOTE: For Schematic Use Only - Not a Construction Drawing

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**REGIONAL FAULT MAP**
Lake Drive Storm Drain Improvements
Southwest of Lake Drive – Cardiff Cove
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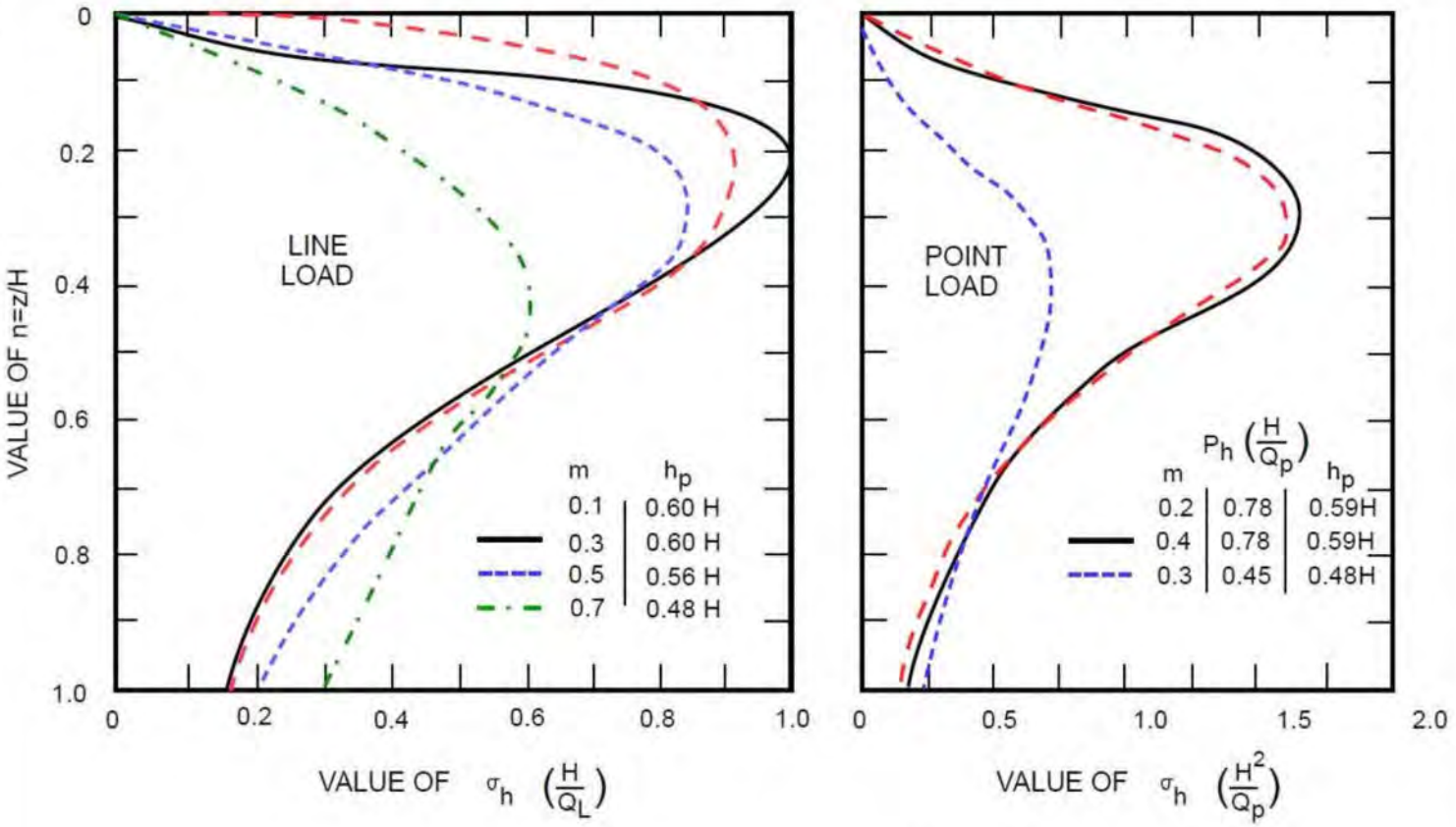
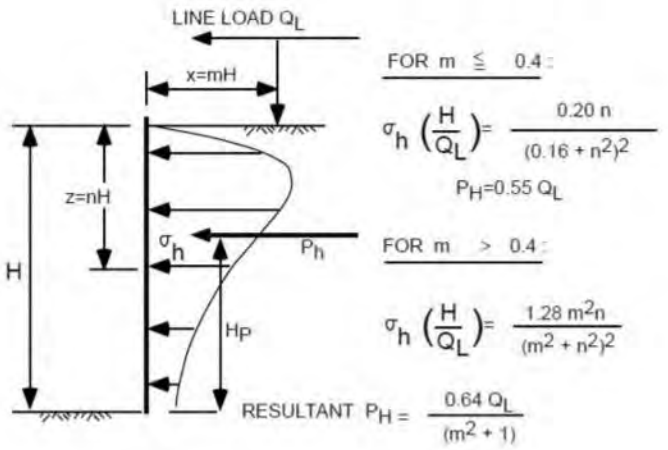
**FIGURE 5**




FOR $m \leq 0.4$ :

$$\sigma_h \left(\frac{H}{Q_L}\right) = \frac{0.20\,n}{(0.16 + n^2)^2}$$

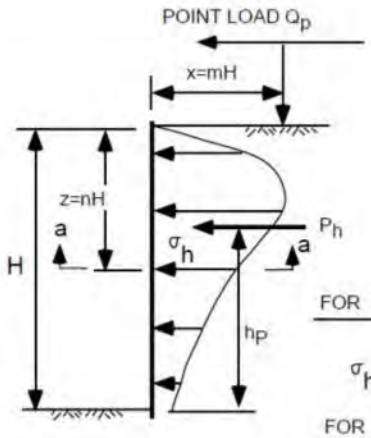
$$P_H = 0.55\,Q_L$$

FOR $m > 0.4$ :

$$\sigma_h \left(\frac{H}{Q_L}\right) = \frac{1.28\,m^2 n}{(m^2 + n^2)^2}$$

RESULTANT $P_H = \frac{0.64\,Q_L}{(m^2 + 1)}$

PRESSURE FROM LINE LOAD $Q_L$
(BOUSSINESQ EQUATION MODIFIED BY EXPERIMENT)



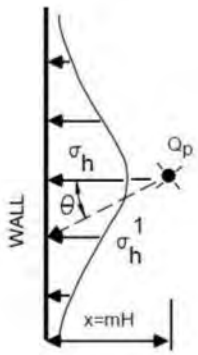

FOR $m \leq 0.4$ :

$$\sigma_h \left(\frac{H^2}{Q_p}\right) = \frac{0.28\,n^2}{(0.16 + n^2)^3}$$

FOR $m > 0.4$ :

$$\sigma_h \left(\frac{H^2}{Q_p}\right) = \frac{1.77\,m^2 n^2}{(m^2 + n^2)^3}$$

$$\sigma_h^1 = \sigma_h \cos 2(1.1\theta)$$




SECTION a -a
PRESSURE FROM POINT LOAD $Q_p$
(BOUSSINESQ EQUATION MODIFIED BY EXPERIMENT)

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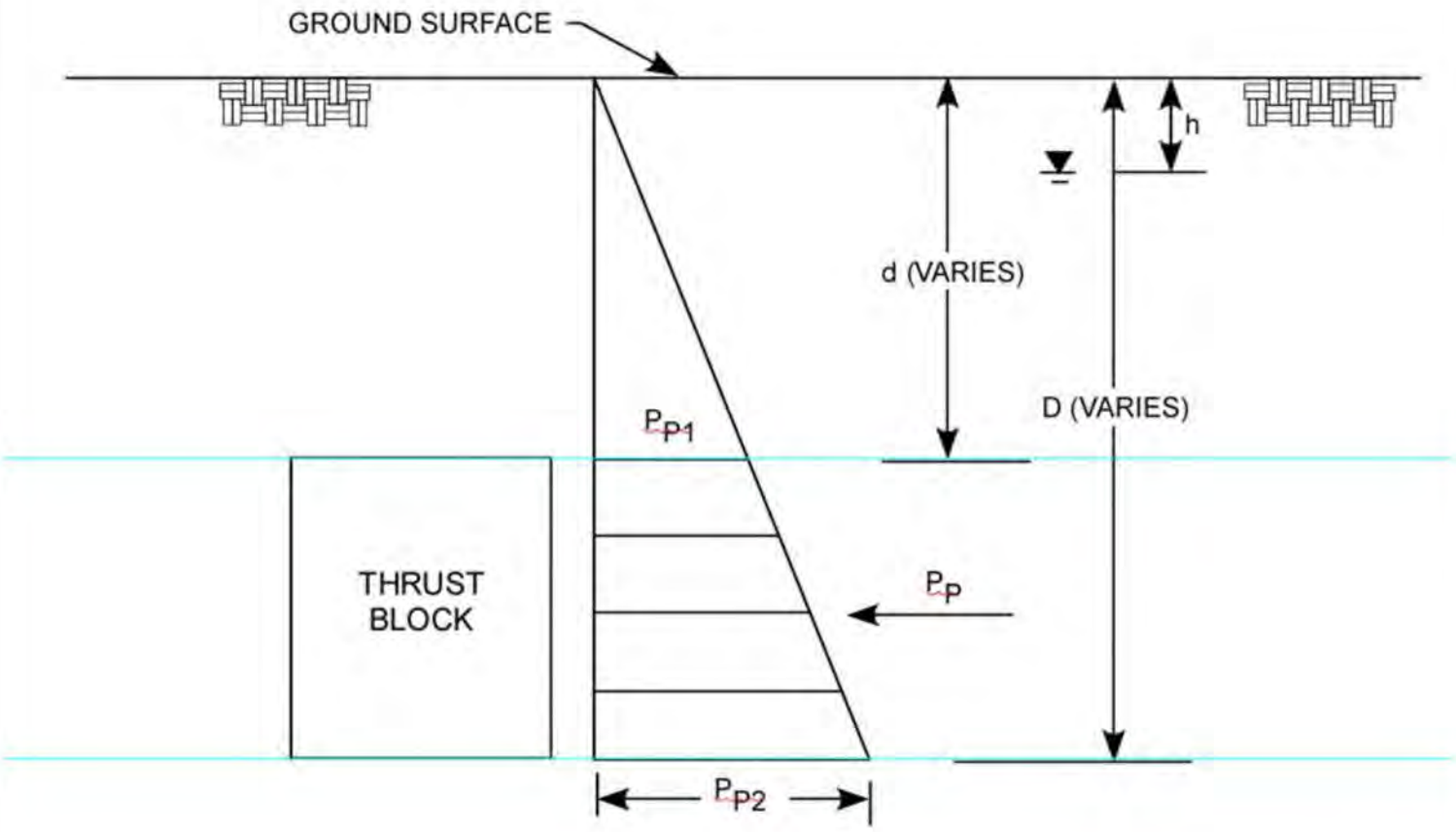
**LATERAL SURCHARGE LOADS**
Lake Drive Storm Drain Improvements
Southwest of Lake Drive – Cardiff Cove
Encinitas, CA

**FIGURE 6**




Notes:

1. Groundwater Below Block
   $P_P = 175\ (D^2-d^2)$ lb/ft
2. Groundwater Above Block
   $P_P = 1.4\ (D-d)[\ 124.8h + 57\ (D+d)]$ lb/ft
3. Assumes Backfill is Granular Material
4. Assumes Thrust Block is Adjacent to Competent Material
5. D, d, and h are in Feet
6. ▼ Groundwater Table

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**THRUST BLOCK DETAIL**
Lake Drive Storm Drain Improvements
Southwest of Lake Drive – Cardiff Cove
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**FIGURE 7**

# APPENDIX A

Exploratory Boring and DCP Test Logs

## Sampling Methods

Representative bulk-disturbed samples were retrieved during exploratory drilling at selected depths appropriate to the investigation. Drilling was accomplished using 3-inch diameter hand auger equipment. The samples were labeled in the field and transported to NV5's laboratory for observation, evaluation, and testing.

## Logging Methods

Earth materials encountered during the field investigation were classified in accordance with the Unified Soil Classification System (USCS/ASTM D2487) and ASTM D2488, and augmented with ASTM Standard Testing for Soil (see Appendix B). Blow count data collected during Dynamic Cone Penetrometer (DCP) testing was used to assess consistency of cohesive soils (clays and silts) and apparent density of granular soils (sands and gravels) using the correlation chart provided on the DCP logs. Refer to the following charts (Chart 1 and Chart 2) for detailed descriptions of logging methods.

## Dynamic Cone Penetrometer (DCP) Test Methods

The WILDCAT DCP testing apparatus utilizes a dedicated expendable 3.59cm diameter cone tip attached to the bottom of a 2.75cm diameter steel rod. The cone tip is advanced into the ground with a 35-pound, gravity driven slide-hammer and biodegradable lubricating fluids are intermittently injected through the rod to the base to reduce the skin friction of the rod during advancement. Blow counts are recorded for each 4-inch increment embedded into the ground surface and advancement is terminated at the desired target depth or when 50 blows for < 4-inch interval is achieved, whichever comes first. Blow counts are then correlated with subsurface soils encountered in the adjacent hand augered boring to determine estimates of apparent density/consistency of soils.

## SAMPLE/SAMPLER TYPE GRAPHICS

- AUGER SAMPLE
- STANDARD PENETRATION SPLIT SPOON SAMPLER
- BULK / GRAB SAMPLE
- CALIFORNIA MODIFIED SPLIT SPOON SAMPLER
- SHELBY TUBE SAMPLER
- HQ ROCK CORE SAMPLE
- NQ ROCK CORE SAMPLE

## GROUNDWATER LEVEL GRAPHICS

- WATER LEVEL (during drilling operations)
- WATER LEVEL (immediately after drilling completion)
- WATER LEVEL (additional levels after drilling completion)
- OBSERVED SEEPAGE

## NOTES

- The report and graphics key are an intergral part of these logs. All data and interpretations in this log are subject to the explanations and limitations stated in the report.
- Lines separating strata on the logs represent approximate boundaries only. Actual transitions my be gradual or differ from those shown.
- No warranty is provided as to the continuity of soil or rock conditions between individual sample locations.
- Logs represent general soil or rock conditions observed at the point of exploration on the date indicated.
- In general, Unified Soil Classification System (USCS) designationspresented on the logs were based on visual classification in thefield and were modified where appropriate based on gradation andindex property testing.
- Fine grained soils that plot within the hatched area on the Plasticity Chart, and coarse grained soils with between 5 and 12% passing the No. 200 sieve require dual USCS symbols, ie., GW-GM, GP-GM, GW-GC, GP-GC, GC-GM, SW-SM, SP-SM, SW-SC, SP-SC, SC-SM.
- If sampler is not able to be driven at least 6 inches then Y/X indicates Y number of blows required to drive the identified sampler X inches with a 140 pound hammer falling 30 inches.

## UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487)

| | | | | | | |
|---|---|---|---|---|---|---|
| COARSE GRAINED SOILS (More than half of materials is larger than the #200 sieve) | GRAVELS (More than half of coarse fraction is larger than the #4 sieve) | CLEAN GRAVEL WITH <5% FINES | Cu≥4 and 1≤Cc≤3 | | GW | WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES |
| | | | Cu<4 and/or 1>Cc>3 | | GP | POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES |
| | | GRAVELS WITH 5 TO 12% FINES | Cu≥4 and 1≤Cc≤3 | | GW-GM | WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE FINES |
| | | | Cu<4 and/or 1>Cc>3 | | GW-GC | WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE CLAY FINES |
| | | | Cu<4 and/or 1>Cc>3 | | GP-GM | POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE FINES |
| | | | | | GP-GC | POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE CLAY FINES |
| | | GRAVELS WITH >12% FINES | | | GM | SILTY GRAVELS, GRAVEL-SILT-SAND MIXTURES |
| | | | | | GC | CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES |
| | | | | | GC-GM | CLAYEY GRAVELS, GRAVEL-SAND-CLAY-SILT MIXTURES |
| | SANDS (More than half of coarse fraction is smaller than the #4 sieve) | CLEAN SANDS WITH <5% FINES | Cu≥6 and 1≤Cc≤3 | | SW | WELL GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES |
| | | | Cu<6 and/or 1>Cc>3 | | SP | POORLY-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES |
| | | SAND WITH 5 TO 12% FINES | Cu≥6 and 1≤Cc≤3 | | SW-SM | WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE FINES |
| | | | | | SW-SC | WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE CLAY FINES |
| | | | Cu>6 and/or 1<Cc>3 | | SP-SM | POORLY GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE FINES |
| | | | | | SP-SC | POORLY-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE CLAY FINES |
| | | SANDS WITH >12% FINES | | | SM | SILTY SANDS, SAND-GRAVEL-SILT MIXTURES |
| | | | | | SC | CLAYEY SANDS, SAND-GRAVEL-CLAY MIXTURES |
| | | | | | SC-SM | CLAYEY SANDS, SAND-SILT-CLAY MIXTURES |
| FINE GRAINED SOILS (More than half of material is smaller than the #200 sieve) | SILTS AND CLAYS (Liquid Limit less than 50) | | | | ML | INORGANIC SILTS AND VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS, SILTS WITH SLIGHT PLASTICITY |
| | | | | | CL | INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS |
| | | | | | CL-ML | INORGANIC CLAYS-SILTS OF LOW PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SITLY CLAYS, LEAN CLAYS |
| | | | | | OL | ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PLASTICITY |
| | SILTS AND CLAYS (Liquid Limit greater than 50) | | | | MH | INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILT |
| | | | | | CH | INORGANIC CLAYS OF HIGH PLASTICITY FAT CLAYS |
| | | | |  | OH | ORGANIC CLAYS & ORGANIC SILTS OF MEDIUM-TO-HIGH PLASTICITY |

N|V|5
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Project No: **226817-0000198.16**

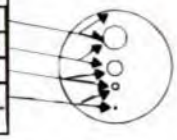
Date: **April 2021**

**BORING LOG LEGEND**
Lake Drive Storm Drain Improvements
Southwest of Lake Drive - Cardiff Cove
Encinitas, CA

**CHART 1**

## GRAIN SIZE

| DESCRIPTION | | SIEVE SIZE | GRAIN SIZE | APPROXIMATE SIZE |
|---|---|---|---|---|
| Boulders | | >12 in. | >12 in. (304.8 mm.) | Larger than basketball-sized |
| Cobbles | | 3 - 12 in. | 3 - 12 in. (76.2 - 304.8 mm.) | Fist-sized to basketball-sized |
| Gravel | coarse | 3/4 - 3 in. | 3/4 - 3 in. (19 - 76.2 mm.) | Thumb-sized to fist-sized |
| | fine | #4 - 3/4 in. | 0.19 - 0.75 in. (4.75 - 19 mm.) | Pea-sized to thumb-sized |
| Sand | coarse | #10 - #4 | 0.079 - 0.19 in. (2 - 4.75 mm.) | Rock salt-sized to pea-sized |
| | medium | #40 - #10 | 0.017 - 0.079 in. (0.43 - 2 mm.) | Sugar-sized to rock salt-sized |
| | fine | #200 - #40 | 0.0029 - 0.017 in. (0.074 - 0.43 mm.) | Four-sized to sugar-sized |
| Fines | | Passing #200 | <0.0029 in. (0.074 mm.) | Flour-sized and smaller |



## ANGULARITY

| DESCRIPTION | CRITERIA |
|---|---|
| Angular | Particles have sharp edges and relatively plane sides with unpolished surfaces |
| Subangular | Particles are similar to angular description but have rounded edges |
| Subrounded | Particles have nearly plane sides but have well-rounded edges |
| Rounded | Particles have smoothly curved sides and no edges |

## PLASTICITY

| DESCRIPTION | CRITERIA |
|---|---|
| Non-plastic | A 1/8-in. (3 mm.) thread cannot be rolled at any water content. |
| Low (L) | The thread can barely be rolled and the lump or thread cannot be formed when drier than the plastic limit. |
| Medium (M) | The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump or thread crumbles when drier than the plastic limit. |
| High (H) | It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump or thread can be formed without crumbling when drier than the plastic limit. |

## MOISTURE CONTENT

| 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 groundwater table |

## REACTION WITH HYDROCHLORIC ACID

| DESCRIPTION | CRITERIA |
|---|---|
| None | No visible reaction |
| Weak | Some reaction, with bubbles forming slowly |
| Strong | Violet reaction, with bubbles forming immediately |

## APPARENT DENSITY - COARSE-GRAINED SOIL

| APPARENT DENSITY | SPT-$N_{60}$ (#blows/ft) | CALIFORNIA MODIFIED SPLIT SPOON SAMPLER (#blows/ft) |
|---|---|---|
| Very Loose | <4 | <5 |
| Loose | 4 - 10 | 6 - 15 |
| Medium Dense | 11 - 30 | 16 - 45 |
| Dense | 31 - 50 | 46 - 75 |
| Very Dense | >50 | >75 |

## CONSISTENCY - FINE-GRAINED SOIL

| CONSISTENCY | SPT-$N_{60}$ (#blows/ft) | CRITERIA | P.P. (TSF) |
|---|---|---|---|
| Very Soft | <2 | Thumb will penetrate soil more than 1 in. (25 mm.) | <0.25 |
| Soft | 2 - 4 | Thumb will penetrate soil about 1 in. (25 mm.) | 0.25 - 0.5 |
| Medium Stiff | 5 - 8 | Thumb will indent soil about 1/4-in. (6 mm.) | 0.5 - 1.0 |
| Stiff | 9 - 15 | Thumb will not indent soil but readily indented with thumbnail | 1.0 - 2.0 |
| Very Stiff | 16 - 30 | Readily indented with nail not thumb | 2.0 - 4.0 |
| Hard | >30 | Thumbnail will not indent soil | >4.0 |

## STRUCTURE

| DESCRIPTION | CRITERIA |
|---|---|
| Stratified | Alternating layers of varying material or color with layers at least 1/4-in. (6 mm.) thick, note thickness |
| Laminated | Alternating layers of varying material or color with layers less than 1/4-in. (6 mm.) thick, note thickness |
| Fissured | Breaks along definite planes of fracture with little resistance to fracturing |
| Slickensided | Fracture planes appear polished or glossy, sometimes striated |
| Blocky | Cohesive soil that can be broken down into smaller angular lumps which resist further breakdown |
| Lensed | Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness |
| Homogeneous | Same color and appearance throughout |

## CEMENTATION

| DESCRIPTION | CRITERIA |
|---|---|
| Weakly | Crumbles or breaks with handling or slight finger pressure |
| Moderately | Crumbles or breaks with considerable finger pressure |
| Strongly | Will not crumble or break with finger pressure |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Project No: **226817-0000198.16**

Date: **April 2021**

**SOIL CLASSIFICATION**
Lake Drive Storm Drain Improvements
Southwest of Lake Drive - Cardiff Cove
Encinitas, CA

**CHART 2**

NV5

# Hand Auger Boring Log



| Date | Project Number | Project | Boring No. |
|---|---|---|---|
| Started: 1/14/2021<br>Completed: 1/14/2021 | 226817-0000198.16 | Lake Drive Storm Drain Improvements | HAB-1 |
| Hammer Efficiency: N/A | Rig Type: Hand Auger | Logged By: S. Burford | Reviewed By: P. Cunningham |
| Latitude: 33.01874 | Longitude: 117.26695 | Surface Elevation: 191' | |

Location: Cardiff

**Sample Type**
G - Bulk / Grab Sample
SPT - 2" O.D. 1.4" I.D. Tube Sample
CAL - 3 " O.D. 2.4" I.D. Ring Sample
NR - No Recovery
* - Uncorrected Blow Counts

**Groundwater**

| Depth (ft) | Hour | Date |
|---|---|---|
| | | |
| | | |

| Groundwater Depth (ft.) / Depth (ft.) | Graphical Log | Sample Taken | Sample ID | Penetration Resistance (Blows per 6 in.) | Moisture Content (%) | Dry Weight (pcf) | Other Tests and Remarks | USCS Class. | Visual Classification |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | SM | **TOPSOIL:** Silty SAND (SM): Light brown, dry, fine to medium-grained sand<br>0.5' El. 190.5' |
| | | | BAG- 1 | | | | | | **FILL:** Silty SAND (SM): Light brown to gray brown, dry to moist, very dense, fine to medium-grained sand |
| | | | G- 1 | | 8.2 | | Moisture Content<br>Sieve Analysis<br>Maximum Density<br>Direct Shear (Remolded)<br>Corrosivity | SM | Color change to brown / dark brown. Traces of organics including roots |
| 5 | | | | | | | | | 5.0' El. 186.0' |
| | | | BAG- 2 | | 4.7 | | Moisture Content | SM | **TORREY SANDSTONE (Tt):** Silty SAND (SM): Gray brown with orange oxidation, moist, fine to medium-grained sand |
| | | | | | | | | | 7.0' El. 184.0' |

Notes: Boring terminated at 7.0' BGS. Groundwater not encountered. Refusal not encountered. Drilled using 3" O.D. hand auger.

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# Hand Auger Boring Log



| Date | Project Number | Project | Boring No. |
|---|---|---|---|
| Started: 1/14/2021<br>Completed: 1/14/2021 | 226817-0000198.16 | Lake Drive Storm Drain Improvements | HAB-2 |
| Hammer Efficiency: N/A | Rig Type: Hand Auger | Logged By: S. Burford | Reviewed By: P. Cunningham |
| Latitude: 33.01836 | Longitude: 117.26721 | Surface Elevation: 177' | |

Location: Cardiff

**Sample Type**
G - Bulk / Grab Sample
SPT - 2" O.D. 1.4" I.D. Tube Sample
CAL - 3 " O.D. 2.4" I.D. Ring Sample
NR - No Recovery
* - Uncorrected Blow Counts

**Groundwater**

| Depth (ft) | Hour | Date |
|---|---|---|
| | | |
| | | |

| Groundwater Depth (ft.) / Depth (ft.) | Graphical Log | Sample Taken | Sample ID | Penetration Resistance (Blows per 6 in.) | Moisture Content (%) | Dry Weight (pcf) | Other Tests and Remarks | USCS Class. | Visual Classification |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | SM | **TOPSOIL:** Silty SAND (SM): Brown, dry, very loose, fine to medium-grained sand, traces of organic material |
| 0.5' | | | | | | | | | El. 176.5' |
| | | | BAG- 1 | | | | | | **COLLUVIUM:** Silty SAND (SM): Gray brown to brown, moist, medium dense, fine to medium-grained sand |
| | | | BAG- 2 | | 8.2 | | Moisture Content | | |
| | | | | | | | | SM | |
| 5 | | | BAG- 3 | | 7.6 | | Moisture Content | | |
| | | | BAG- 4 | | 6.1 | | Moisture Content | | |
| 8.0' | | | | | | | | | El. 169.0' |

Notes: Boring terminated at 8.0' BGS. Groundwater not encountered. Refusal not encountered. Drilled using 3" O.D. hand auger.

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# Hand Auger Boring Log



| Date | Project Number | Project | Boring No. |
|---|---|---|---|
| Started: 1/14/2021<br>Completed: 1/14/2021 | 226817-0000198.16 | Lake Drive Storm Drain Improvements | HAB-3 |
| Hammer Efficiency: N/A | Rig Type: Hand Auger | Logged By: S. Burford | Reviewed By: P. Cunningham |
| Latitude: 33.01801 | Longitude: 117.26764 | Surface Elevation: 169' | |

Location: Cardiff

**Sample Type**
G - Bulk / Grab Sample
SPT - 2" O.D. 1.4" I.D. Tube Sample
CAL - 3 " O.D. 2.4" I.D. Ring Sample
NR - No Recovery
* - Uncorrected Blow Counts

**Groundwater**

| Depth (ft) | Hour | Date |
|---|---|---|
| | | |
| | | |

| Groundwater Depth (ft.) / Depth (ft.) | Graphical Log | Sample Taken | Sample ID | Penetration Resistance (Blows per 6 in.) | Moisture Content (%) | Dry Weight (pcf) | Other Tests and Remarks | USCS Class. | Visual Classification |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | SM | **TOPSOIL:** Silty SAND (SM): Brown, dry, fine to medium-grained sand, traces of organic material |
| 0.5' | | | | | | | | | El. 168.5' |
| | | | BAG- 1 | | | | | SM | **COLLUVIUM:** Silty SAND (SM): Gray brown, moist, medium dense, fine to medium-grained sand |
| 3.0' | | | | | | | | | El. 166.0' |
| | | | BAG- 2 | | 4.5 | | Moisture Content | SM | **TORREY SANDSTONE (Tt):** Silty SAND (SM): Gray brown, moist, very dense, fine to medium-grained sand |
| 4.0' | | | | | | | | | El. 165.0' |

Notes: Boring terminated at 4.0' BGS. Groundwater not encountered. Refusal not encountered. Drilled using 3" O.D. hand auger.

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# Hand Auger Boring Log



| Date | Project Number | Project | Boring No. |
|---|---|---|---|
| Started: 1/14/2021<br>Completed: 1/14/2021 | 226817-0000198.16 | Lake Drive Storm Drain Improvements | HAB-4 |
| Hammer Efficiency: N/A | Rig Type: Hand Auger | Logged By: S. Burford | Reviewed By: P. Cunningham |
| Latitude: 33.01765 | Longitude: 117.26814 | Surface Elevation: 158' | |

Location: Cardiff

**Sample Type**
G - Bulk / Grab Sample
SPT - 2" O.D. 1.4" I.D. Tube Sample
CAL - 3 " O.D. 2.4" I.D. Ring Sample
NR - No Recovery
* - Uncorrected Blow Counts

**Groundwater**

| Depth (ft) | Hour | Date |
|---|---|---|
| | | |
| | | |

| Groundwater Depth (ft.) / Depth (ft.) | Graphical Log | Sample Taken | Sample ID | Penetration Resistance (Blows per 6 in.) | Moisture Content (%) | Dry Weight (pcf) | Other Tests and Remarks | USCS Class. | Visual Classification |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | SM | **TOPSOIL:** Silty SAND (SM): Brown, dry, fine to medium-grained sand<br>1.0' El. 157.0' |
| | | | BAG- 1 | | | | | SM | **COLLUVIUM:** Silty SAND (SM): Gray brown, moist, medium dense, fine to medium-grained sand, small lenses of clay and traces of rounded gravel<br>2.5' El. 155.5' |
| | | | BAG- 2 | | 6.1 | | Moisture Content | SM | **TORREY SANDSTONE (Tt):** Silty SAND (SM): Orange brown, moist, dense to very dense, fine to medium-grained sand |
| 5 | | | BAG- 3 | | 6.9 | | Moisture Content | | 5.0' El. 153.0' |

Notes: Boring terminated at 5.0' BGS. Groundwater not encountered. Refusal not encountered. Drilled using 3" O.D. hand auger.

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NV5

# Hand Auger Boring Log



| Date | Project Number | Project | Boring No. |
|---|---|---|---|
| Started: 1/14/2021<br>Completed: 1/14/2021 | 226817-0000198.16 | Lake Drive Storm Drain Improvements | HAB-5 |
| Hammer Efficiency: N/A | Rig Type: Hand Auger | Logged By: S. Burford | Reviewed By: P. Cunningham |
| Latitude: 33.01724 | Longitude: 117.26850 | Surface Elevation: 144' | |

Location: Cardiff

**Sample Type**
G - Bulk / Grab Sample
SPT - 2" O.D. 1.4" I.D. Tube Sample
CAL - 3 " O.D. 2.4" I.D. Ring Sample
NR - No Recovery
* - Uncorrected Blow Counts

**Groundwater**

| Depth (ft) | Hour | Date |
|---|---|---|
| | | |
| | | |

| Groundwater Depth (ft.) / Depth (ft.) | Graphical Log | Sample Taken | Sample ID | Penetration Resistance (Blows per 6 in.) | Moisture Content (%) | Dry Weight (pcf) | Other Tests and Remarks | USCS Class. | Visual Classification |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | SM | **TOPSOIL:** Silty SAND (SM): Brown, dry to moist, fine to medium-grained sand, traces of organic material |
| 1.0' | | | | | | | | | El. 143.0' |
| | | | BAG- 1 | | | | | SM | **TORREY SANDSTONE (Tt):** Silty SAND (SM): Gray brown with orange oxidation, moist, dense to very dense, fine to medium-grained sand |
| | | | BAG- 1 | | 6.9 | | Moisture Content | | |
| 3.5' | | | | | | | | | El. 140.5' |

Notes: Boring terminated at 3.5' BGS. Groundwater not encountered. Refusal not encountered. Drilled using 3" O.D. hand auger.

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# Hand Auger Boring Log



| Date | Project Number | Project | Boring No. |
|---|---|---|---|
| Started: 1/15/2021<br>Completed: 1/15/2021 | 226817-0000198.16 | Lake Drive Storm Drain Improvements | HAB-6 |
| Hammer Efficiency: N/A | Rig Type: Hand Auger | Logged By: S. Burford | Reviewed By: P. Cunningham |
| Latitude: 33.01690 | Longitude: 117.26878 | Surface Elevation: 140' | |

Location: Cardiff

**Sample Type**
G - Bulk / Grab Sample
SPT - 2" O.D. 1.4" I.D. Tube Sample
CAL - 3 " O.D. 2.4" I.D. Ring Sample
NR - No Recovery
* - Uncorrected Blow Counts

**Groundwater**

| Depth (ft) | Hour | Date |
|---|---|---|
| | | |
| | | |

| Groundwater Depth (ft.) / Depth (ft.) | Graphical Log | Sample Taken | Sample ID | Penetration Resistance (Blows per 6 in.) | Moisture Content (%) | Dry Weight (pcf) | Other Tests and Remarks | USCS Class. | Visual Classification |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | SM | **TOPSOIL:** Silty SAND (SM): Brown, dry to moist, loose, fine to medium-grained sand, traces of organic material |
| 0.5' | | | | | | | | | El. 139.5' |
| | | | BAG- 1 | | | | | SM | **COLLUVIUM:** Silty SAND (SM): Gray brown, moist, medium dense to very dense, fine to medium-grained sand |
| 3.0' | | | | | | | | | El. 137.0' |
| | | | BAG- 2 | | 2.7 | | Moisture Content | SM | **TORREY SANDSTONE (Tt):** Silty SAND (SM): Gray brown with orange oxidation, moist, dense to very dense, fine to medium-grained sand |
| | | | BAG- 3 | | 3.5 | | Moisture Content | | |
| 5 | | | | | | | | | |
| 5.0' | | | | | | | | | El. 135.0' |

Notes: Boring terminated at 5.0' BGS. Groundwater not encountered. Refusal not encountered. Drilled using 3" O.D. hand auger.

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# Hand Auger Boring Log



| Date | Project Number | Project | Boring No. |
|---|---|---|---|
| Started: 1/18/2021<br>Completed: 1/18/2021 | 226817-0000198.16 | Lake Drive Storm Drain Improvements | HAB-7 |
| Hammer Efficiency: N/A | Rig Type: Hand Auger | Logged By: S. Burford | Reviewed By: P. Cunningham |
| Latitude: 33.01655 | Longitude: 117.26920 | Surface Elevation: 121' | |

Location: Cardiff

**Sample Type**
G - Bulk / Grab Sample
SPT - 2" O.D. 1.4" I.D. Tube Sample
CAL - 3 " O.D. 2.4" I.D. Ring Sample
NR - No Recovery
* - Uncorrected Blow Counts

**Groundwater**

| Depth (ft) | Hour | Date |
|---|---|---|
| | | |
| | | |

| Groundwater Depth (ft.) / Depth (ft.) | Graphical Log | Sample Taken | Sample ID | Penetration Resistance (Blows per 6 in.) | Moisture Content (%) | Dry Weight (pcf) | Other Tests and Remarks | USCS Class. | Visual Classification |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | | BAG- 1 | | | | | SM | **COLLUVIUM:** Silty SAND (SM): Yellow brown to gray brown, moist, medium dense, fine to medium-grained sand, trace of organic material upper 6" |
| 3.0' | | | | | | | | | El. 118.0' |
| | | | BAG- 2 | | 5.4 | | Moisture Content | SM | **TORREY SANDSTONE (Tt):** Silty SAND (SM): Gray brown with orange oxidation, moist, dense, fine to medium-grained sand |
| 4.0' | | | | | | | | | El. 117.0' |

Notes: Boring terminated at 4.0' BGS. Groundwater not encountered. Refusal not encountered. Drilled using 3" O.D. hand auger.

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# Hand Auger Boring Log



| Date | Project Number | Project | Boring No. |
|---|---|---|---|
| Started: 1/18/2021<br>Completed: 1/18/2021 | 226817-0000198.16 | Lake Drive Storm Drain Improvements | HAB-8 |
| Hammer Efficiency: N/A | Rig Type: Hand Auger | Logged By: S. Burford | Reviewed By: P. Cunningham |
| Latitude: 33.01633 | Longitude: 117.26954 | Surface Elevation: 119' | |

Location: Cardiff

**Sample Type**
G - Bulk / Grab Sample
SPT - 2" O.D. 1.4" I.D. Tube Sample
CAL - 3 " O.D. 2.4" I.D. Ring Sample
NR - No Recovery
* - Uncorrected Blow Counts

**Groundwater**

| Depth (ft) | Hour | Date |
|---|---|---|
| | | |
| | | |

| Groundwater Depth (ft.) / Depth (ft.) | Graphical Log | Sample Taken | Sample ID | Penetration Resistance (Blows per 6 in.) | Moisture Content (%) | Dry Weight (pcf) | Other Tests and Remarks | USCS Class. | Visual Classification |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | | BAG- 1 | | | | | | **FILL:** Silty SAND (SM): Yellow brown to gray brown, moist, medium dense to dense, fine to medium-grained sand with traces of gravel and small cobbles and trace organic material |
| | | | | | | | | | Becomes gray brown with orange oxidation with small lenses of clay |
| 5 | | | G- 1 | | 12.7 | | Moisture Content<br>Sieve Analysis<br>Maximum Density<br>Direct Shear (Remolded)<br>Expansion Index<br>Corrosivity | SM | Becomes loose at 4.5' BGS |
| | | | BAG- 2 | | 16.3 | | Moisture Content | | |
| | | | | | | | | | 8.5' El. 110.5' |
| | | | | | | | | SM | 9.0' **TORREY SANDSTONE (Tt):** Silty SAND (SM): Gray brown with orange oxidation, moist, fine to medium-grained sand, small lenses of clay El. 110.0' |

Notes: Boring terminated at 9.0' BGS. Groundwater not encountered. Refusal not encountered. Drilled using 3" O.D. hand auger.

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NV5

# Hand Auger Boring Log



| Date | Project Number | Project | Boring No. |
|---|---|---|---|
| Started: 1/18/2021<br>Completed: 1/18/2021 | 226817-0000198.16 | Lake Drive Storm Drain Improvements | HAB-9 |
| Hammer Efficiency: N/A | Rig Type: Hand Auger | Logged By: S. Burford | Reviewed By: P. Cunningham |
| Latitude: 33.01584 | Longitude: 117.26934 | Surface Elevation: 114' | |

Location: Cardiff

**Sample Type**
G - Bulk / Grab Sample
SPT - 2" O.D. 1.4" I.D. Tube Sample
CAL - 3 " O.D. 2.4" I.D. Ring Sample
NR - No Recovery
* - Uncorrected Blow Counts

**Groundwater**

| Depth (ft) | Hour | Date |
|---|---|---|
| | | |
| | | |

| Groundwater Depth (ft.) / Depth (ft.) | Graphical Log | Sample Taken | Sample ID | Penetration Resistance (Blows per 6 in.) | Moisture Content (%) | Dry Weight (pcf) | Other Tests and Remarks | USCS Class. | Visual Classification |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | SM | **TOPSOIL:** Silty SAND (SM): Gray brown, moist, loose, fine to medium-grained sand, trace organic material |
| 0.5' | | | | | | | | | El. 113.5' |
| | | | | | | | | | **COLLUVIUM:** Silty SAND (SM): Gray brown, moist, medium dense, fine to medium-grained sand |
| | | | BAG- 1 | | 3.5 | | Moisture Content | | |
| 5 | | | | | | | | SM | |
| | | | | | | | | | Moisture increases below 7.5' BGS |
| 10 | | | | | | | | | |
| 11.5' | | | | | | | | | El. 102.5' |
| | | | | | | | | | **TORREY SANDSTONE (Tt):** Silty SAND (SM): Gray brown with orange oxidation, moist, fine to medium-grained sand |
| | | | BAG- 2 | | 6.8 | | Moisture Content | SM | |
| 13.0' | | | | | | | | | El. 101.0' |

Notes: Boring terminated at 13.0' BGS. Groundwater not encountered. Refusal not encountered. Drilled using 3" O.D. hand auger.

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NV5

# Hand Auger Boring Log



| Date | Project Number | Project | Boring No. |
|---|---|---|---|
| Started: 1/18/2021<br>Completed: 1/18/2021 | 226817-0000198.16 | Lake Drive Storm Drain Improvements | HAB-10 |
| Hammer Efficiency: N/A | Rig Type: Hand Auger | Logged By: S. Burford | Reviewed By: P. Cunningham |
| Latitude: 33.01532 | Longitude: 117.26943 | Surface Elevation: 108' | |

Location: Cardiff

**Sample Type**
G - Bulk / Grab Sample
SPT - 2" O.D. 1.4" I.D. Tube Sample
CAL - 3 " O.D. 2.4" I.D. Ring Sample
NR - No Recovery
* - Uncorrected Blow Counts

**Groundwater**

| Depth (ft) | Hour | Date |
|---|---|---|
| 10.5 | 1:00pm | 1/18/21 |
| | | |

| Groundwater Depth (ft.) / Depth (ft.) | Graphical Log | Sample Taken | Sample ID | Penetration Resistance (Blows per 6 in.) | Moisture Content (%) | Dry Weight (pcf) | Other Tests and Remarks | USCS Class. | Visual Classification |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | | **COLLUVIUM:** Silty SAND (SM): Gray brown to orange brown, moist, loose, fine to medium-grained sand |
| | | | | | | | | | Becomes medium dense at 1.5' BGS |
| | | | BAG- 1 | | | | | | |
| | | | | | | | | | Becomes dense at 3.5' BGS |
| 5 | | | G- 1 | | 10.1 | | Moisture Content | | |
| | | | | | | | | SM | |
| 10 | | | | | | | | | Soil becomes wet at 10.5' BGS. Cobble and gravel layer at 12.0' BGS basal contact of colluvium and Torrey Sandstone |
| | | | | | | | | | 12.0' El. 96.0' |
| | | | | | | | | SM | **TORREY SANDSTONE (Tt):** Silty SAND (SM): Gray brown with orange oxidation, moist, fine to medium-grained sand |
| | | | | | | | | | 12.5' El. 95.5' |

Notes: Boring terminated at 12.5' BGS. Groundwater encountered at 10.5' BGS. Refusal encountered on formational material at 12.5' BGS. Drilled using 3" O.D. hand auger.

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# Hand Auger Boring Log



| Date | Project Number | Project | Boring No. |
|---|---|---|---|
| Started: 1/15/2021<br>Completed: 1/15/2021 | 226817-0000198.16 | Lake Drive Storm Drain Improvements | HAB-11 |
| Hammer Efficiency: N/A | Rig Type: Hand Auger | Logged By: S. Burford | Reviewed By: P. Cunningham |
| Latitude: 33.01710 | Longitude: 117.26928 | Surface Elevation: 144' | |

Location: Cardiff

**Sample Type**
G - Bulk / Grab Sample
SPT - 2" O.D. 1.4" I.D. Tube Sample
CAL - 3 " O.D. 2.4" I.D. Ring Sample
NR - No Recovery
* - Uncorrected Blow Counts

**Groundwater**

| Depth (ft) | Hour | Date |
|---|---|---|
| | | |
| | | |

| Groundwater Depth (ft.) / Depth (ft.) | Graphical Log | Sample Taken | Sample ID | Penetration Resistance (Blows per 6 in.) | Moisture Content (%) | Dry Weight (pcf) | Other Tests and Remarks | USCS Class. | Visual Classification |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | SM | **TOPSOIL:** Silty SAND (SM): Brown, moist, fine to medium-grained sand, traces of organic material |
| 1.0' | | | | | | | | | El. 143.0' |
| | | | BAG- 1 | | | | | SM | **TORREY SANDSTONE (Tt):** Silty SAND (SM): Gray brown with orange oxidation, moist, dense to very dense, fine to medium-grained sand |
| | | | G- 1 | | 7.0 | | Moisture Content | | |
| 5 | | | | | | | | | |
| 5.0' | | | | | | | | | El. 139.0' |

Notes: Boring terminated at 5.0' BGS. Groundwater not encountered. Refusal not encountered. Drilled using 3" O.D. hand auger.

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# Hand Auger Boring Log



| Date | Project Number | Project | Boring No. |
|---|---|---|---|
| Started: 1/15/2021<br>Completed: 1/15/2021 | 226817-0000198.16 | Lake Drive Storm Drain Improvements | HAB-12 |
| Hammer Efficiency: N/A | Rig Type: Hand Auger | Logged By: S. Burford | Reviewed By: P. Cunningham |
| Latitude: 33.01774 | Longitude: 117.26940 | Surface Elevation: 167' | |

Location: Cardiff

**Sample Type**
G - Bulk / Grab Sample
SPT - 2" O.D. 1.4" I.D. Tube Sample
CAL - 3 " O.D. 2.4" I.D. Ring Sample
NR - No Recovery
* - Uncorrected Blow Counts

**Groundwater**

| Depth (ft) | Hour | Date |
|---|---|---|
| | | |
| | | |

| Groundwater Depth (ft.) Depth (ft.) | Graphical Log | Sample Taken | Sample ID | Penetration Resistance (Blows per 6 in.) | Moisture Content (%) | Dry Weight (pcf) | Other Tests and Remarks | USCS Class. | Visual Classification |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | SM | **TORREY SANDSTONE (Tt):** Silty SAND (SM): Gray brown with orange oxidation, moist, very dense, fine to medium-grained sand |
| 0.5' | | | | | | | | | El. 166.5' |

Notes: Boring terminated at 0.5' BGS. Groundwater not encountered. Refusal encountered on formational material at 0.5' BGS. Drilled using 3" O.D. hand auger.

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# WILDCAT DYNAMIC CONE LOG



NV5 West, Inc
15092 Ave of Science, Suite 200
San Diego, CA

PROJECT NUMBER: 226817-0000198.16
DATE STARTED: 01-14-2021
DATE COMPLETED: 01-14-2021

HOLE #: DC-1
CREW: Sean B., Sean R.
PROJECT: Lake Drive Storm Drain Replacement
ADDRESS: Lake Drive
LOCATION: Cardiff, CA

SURFACE ELEVATION:
WATER ON COMPLETION: N/A
HAMMER WEIGHT: 35 lbs.
CONE AREA: 10 sq. cm

| DEPTH | BLOWS PER 10 cm | RESISTANCE Kg/cm² | GRAPH OF CONE RESISTANCE 0 50 100 150 | N' | TESTED CONSISTENCY NON-COHESIVE | TESTED CONSISTENCY COHESIVE |
|---|---|---|---|---|---|---|
| - | 3 | 13.3 | ••• | 3 | VERY LOOSE | SOFT |
| - | 18 | 79.9 | •••••••••••••••••••• | 22 | MEDIUM DENSE | VERY STIFF |
| - 1 ft | 50 | 222.0 | •••••••••••••••••••••••••••••••••••••••••••• | 25+ | VERY DENSE | HARD |
| - | | | | | | |
| - | | | | | | |
| - 2 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 3 ft | | | | | | |
| - 1 m | | | | | | |
| - | | | | | | |
| - 4 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 5 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 6 ft | | | | | | |
| - | | | | | | |
| - 2 m | | | | | | |
| - 7 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 8 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 9 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 3 m 10 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 11 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 12 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 4 m 13 ft | | | | | | |

# WILDCAT DYNAMIC CONE LOG



NV5 West, Inc
15092 Ave of Science, Suite 200
San Diego, CA

PROJECT NUMBER: 226817-0000198.16
DATE STARTED: 01-14-2021
DATE COMPLETED: 01-14-2021

HOLE #: DC-2
CREW: Sean B., Sean R.
PROJECT: Lake Drive Storm Drain Replacement
ADDRESS: Lake Drive
LOCATION: Cardiff, CA

SURFACE ELEVATION:
WATER ON COMPLETION: N/A
HAMMER WEIGHT: 35 lbs.
CONE AREA: 10 sq. cm

| DEPTH | BLOWS PER 10 cm | RESISTANCE Kg/cm² | GRAPH OF CONE RESISTANCE 0 50 100 150 | N' | TESTED CONSISTENCY NON-COHESIVE | COHESIVE |
|---|---|---|---|---|---|---|
| - | 3 | 13.3 | ••• | 3 | VERY LOOSE | SOFT |
| - | 10 | 44.4 | •••••••••••• | 12 | MEDIUM DENSE | STIFF |
| - 1 ft | 14 | 62.2 | •••••••••••••••••• | 17 | MEDIUM DENSE | VERY STIFF |
| - | 17 | 75.5 | ••••••••••••••••••••• | 21 | MEDIUM DENSE | VERY STIFF |
| - | 16 | 71.0 | •••••••••••••••••••• | 20 | MEDIUM DENSE | VERY STIFF |
| - 2 ft | 16 | 71.0 | •••••••••••••••••••• | 20 | MEDIUM DENSE | VERY STIFF |
| - | 12 | 53.3 | ••••••••••••••• | 15 | MEDIUM DENSE | STIFF |
| - | 11 | 48.8 | •••••••••••••• | 13 | MEDIUM DENSE | STIFF |
| - 3 ft | 12 | 53.3 | ••••••••••••••• | 15 | MEDIUM DENSE | STIFF |
| - 1 m | 11 | 48.8 | •••••••••••••• | 13 | MEDIUM DENSE | STIFF |
| - | 11 | 42.5 | •••••••••••• | 12 | MEDIUM DENSE | STIFF |
| - 4 ft | 11 | 42.5 | •••••••••••• | 12 | MEDIUM DENSE | STIFF |
| - | 11 | 42.5 | •••••••••••• | 12 | MEDIUM DENSE | STIFF |
| - | 10 | 38.6 | •••••••••••• | 11 | MEDIUM DENSE | STIFF |
| - 5 ft | 11 | 42.5 | •••••••••••• | 12 | MEDIUM DENSE | STIFF |
| - | 11 | 42.5 | •••••••••••• | 12 | MEDIUM DENSE | STIFF |
| - | 14 | 54.0 | ••••••••••••••• | 15 | MEDIUM DENSE | STIFF |
| - 6 ft | 15 | 57.9 | •••••••••••••••• | 16 | MEDIUM DENSE | VERY STIFF |
| - | 12 | 46.3 | •••••••••••••• | 13 | MEDIUM DENSE | STIFF |
| - 2 m | 15 | 57.9 | •••••••••••••••• | 16 | MEDIUM DENSE | VERY STIFF |
| - 7 ft | 19 | 65.0 | •••••••••••••••••• | 18 | MEDIUM DENSE | VERY STIFF |
| - | 19 | 65.0 | •••••••••••••••••• | 18 | MEDIUM DENSE | VERY STIFF |
| - | 14 | 47.9 | •••••••••••••• | 13 | MEDIUM DENSE | STIFF |
| - 8 ft | 19 | 65.0 | •••••••••••••••••• | 18 | MEDIUM DENSE | VERY STIFF |
| - | 20 | 68.4 | ••••••••••••••••••• | 19 | MEDIUM DENSE | VERY STIFF |
| - | 23 | 78.7 | •••••••••••••••••••••• | 22 | MEDIUM DENSE | VERY STIFF |
| - 9 ft | 24 | 82.1 | ••••••••••••••••••••••• | 23 | MEDIUM DENSE | VERY STIFF |
| - | 27 | 92.3 | ••••••••••••••••••••••••• | 25+ | MEDIUM DENSE | VERY STIFF |
| - | 26 | 88.9 | ••••••••••••••••••••••• | 25 | MEDIUM DENSE | VERY STIFF |
| - 3 m 10 ft | 22 | 75.2 | •••••••••••••••••••• | 21 | MEDIUM DENSE | VERY STIFF |
| - | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 11 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 12 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 4 m 13 ft | | | | | | |

# WILDCAT DYNAMIC CONE LOG



NV5 West, Inc
15092 Ave of Science, Suite 200
San Diego, CA

PROJECT NUMBER: 226817-0000198.16
DATE STARTED: 01-14-2021
DATE COMPLETED: 01-14-2021

HOLE #: DC-3
CREW: Sean B., Sean R.
PROJECT: Lake Drive Storm Drain Replacement
ADDRESS: Lake Drive
LOCATION: Cardiff, CA

SURFACE ELEVATION:
WATER ON COMPLETION: N/A
HAMMER WEIGHT: 35 lbs.
CONE AREA: 10 sq. cm

| DEPTH | BLOWS PER 10 cm | RESISTANCE Kg/cm² | GRAPH OF CONE RESISTANCE 0 50 100 150 | N' | TESTED CONSISTENCY NON-COHESIVE | COHESIVE |
|---|---|---|---|---|---|---|
| - | 3 | 13.3 | ••• | 3 | VERY LOOSE | SOFT |
| - | 3 | 13.3 | ••• | 3 | VERY LOOSE | SOFT |
| - 1 ft | 4 | 17.8 | ••••• | 5 | LOOSE | MEDIUM STIFF |
| - | 10 | 44.4 | •••••••••••• | 12 | MEDIUM DENSE | STIFF |
| - | 15 | 66.6 | •••••••••••••••••• | 19 | MEDIUM DENSE | VERY STIFF |
| - 2 ft | 20 | 88.8 | •••••••••••••••••••••••• | 25 | MEDIUM DENSE | VERY STIFF |
| - | 22 | 97.7 | •••••••••••••••••••••••••••• | 25+ | MEDIUM DENSE | VERY STIFF |
| - | 18 | 79.9 | •••••••••••••••••••••• | 22 | MEDIUM DENSE | VERY STIFF |
| - 3 ft | 20 | 88.8 | •••••••••••••••••••••••• | 25 | MEDIUM DENSE | VERY STIFF |
| - 1 m | 39 | 173.2 | •••••••••••••••••••••••••••••••••••••••••• | 25+ | DENSE | HARD |
| - | 50 | 193.0 | •••••••••••••••••••••••••••••••••••••••••• | 25+ | VERY DENSE | HARD |
| - 4 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 5 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 6 ft | | | | | | |
| - | | | | | | |
| - 2 m | | | | | | |
| - 7 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 8 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 9 ft | | | | | | |
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| - 3 m 10 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 11 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 12 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 4 m 13 ft | | | | | | |

# WILDCAT DYNAMIC CONE LOG



NV5 West, Inc
15092 Ave of Science, Suite 200
San Diego, CA

PROJECT NUMBER: 226817-0000198.16
DATE STARTED: 01-14-2021
DATE COMPLETED: 01-14-2021

HOLE #: DC-4
CREW: Sean B., Sean R.
PROJECT: Lake Drive Storm Drain Replacement
ADDRESS: Lake Drive
LOCATION: Cardiff, CA

SURFACE ELEVATION:
WATER ON COMPLETION: N/A
HAMMER WEIGHT: 35 lbs.
CONE AREA: 10 sq. cm

| DEPTH | BLOWS PER 10 cm | RESISTANCE Kg/cm² | GRAPH OF CONE RESISTANCE 0 50 100 150 | N' | TESTED CONSISTENCY NON-COHESIVE | COHESIVE |
|---|---|---|---|---|---|---|
| - | 8 | 35.5 | •••••••••• | 10 | LOOSE | STIFF |
| - | 17 | 75.5 | •••••••••••••••••••• | 21 | MEDIUM DENSE | VERY STIFF |
| - 1 ft | 10 | 44.4 | •••••••••••• | 12 | MEDIUM DENSE | STIFF |
| - | 9 | 40.0 | •••••••••• | 11 | MEDIUM DENSE | STIFF |
| - | 14 | 62.2 | •••••••••••••••••• | 17 | MEDIUM DENSE | VERY STIFF |
| - 2 ft | 13 | 57.7 | •••••••••••••••• | 16 | MEDIUM DENSE | VERY STIFF |
| - | 24 | 106.6 | ••••••••••••••••••••••••••••• | 25+ | MEDIUM DENSE | VERY STIFF |
| - | 34 | 151.0 | •••••••••••••••••••••••••••••••••••••••••• | 25+ | DENSE | HARD |
| - 3 ft | 42 | 186.5 | •••••••••••••••••••••••••••••••••••••••••• | 25+ | VERY DENSE | HARD |
| - 1 m | 42 | 186.5 | •••••••••••••••••••••••••••••••••••••••••• | 25+ | VERY DENSE | HARD |
| - | 33 | 127.4 | •••••••••••••••••••••••••••••••••• | 25+ | DENSE | HARD |
| - 4 ft | 50 | 193.0 | •••••••••••••••••••••••••••••••••••••••••• | 25+ | VERY DENSE | HARD |
| - | | | | | | |
| - | | | | | | |
| - 5 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 6 ft | | | | | | |
| - | | | | | | |
| - 2 m | | | | | | |
| - 7 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 8 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 9 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 3 m 10 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 11 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 12 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 4 m 13 ft | | | | | | |

# WILDCAT DYNAMIC CONE LOG



NV5 West, Inc
15092 Ave of Science, Suite 200
San Diego, CA

PROJECT NUMBER: 226817-0000198.16
DATE STARTED: 01-14-2021
DATE COMPLETED: 01-14-2021

HOLE #: DC-5
CREW: Sean B., Sean R.
PROJECT: Lake Drive Storm Drain Replacement
ADDRESS: Lake Drive
LOCATION: Cardiff, CA

SURFACE ELEVATION:
WATER ON COMPLETION: N/A
HAMMER WEIGHT: 35 lbs.
CONE AREA: 10 sq. cm

| DEPTH | BLOWS PER 10 cm | RESISTANCE Kg/cm² | GRAPH OF CONE RESISTANCE 0 50 100 150 | N' | TESTED CONSISTENCY NON-COHESIVE | COHESIVE |
|---|---|---|---|---|---|---|
| - | 30 | 133.2 | •••••••••••••••••••••••••••••••••• | 25+ | DENSE | HARD |
| - | 48 | 213.1 | •••••••••••••••••••••••••••••••••••••••••• | 25+ | VERY DENSE | HARD |
| - 1 ft | 35 | 155.4 | •••••••••••••••••••••••••••••••••••••••••• | 25+ | DENSE | HARD |
| - | 44 | 195.4 | •••••••••••••••••••••••••••••••••••••••••• | 25+ | VERY DENSE | HARD |
| - | 40 | 177.6 | •••••••••••••••••••••••••••••••••••••••••• | 25+ | DENSE | HARD |
| - 2 ft | 29 | 128.8 | •••••••••••••••••••••••••••••••••• | 25+ | DENSE | HARD |
| - | 30 | 133.2 | •••••••••••••••••••••••••••••••••• | 25+ | DENSE | HARD |
| - | 50 | 222.0 | •••••••••••••••••••••••••••••••••••••••••• | 25+ | VERY DENSE | HARD |
| - 3 ft | 50 | 222.0 | •••••••••••••••••••••••••••••••••••••••••• | 25+ | VERY DENSE | HARD |
| - 1 m | | | | | | |
| - | | | | | | |
| - 4 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 5 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 6 ft | | | | | | |
| - | | | | | | |
| - 2 m | | | | | | |
| - 7 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 8 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 9 ft | | | | | | |
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| - | | | | | | |
| - 3 m 10 ft | | | | | | |
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| - 11 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 12 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 4 m 13 ft | | | | | | |

# WILDCAT DYNAMIC CONE LOG



NV5 West, Inc
15092 Ave of Science, Suite 200
San Diego, CA

PROJECT NUMBER: 226817-0000198.16
DATE STARTED: 01-15-2021
DATE COMPLETED: 01-15-2021

HOLE #: DC-6
CREW: Sean B., Sean R.
PROJECT: Lake Drive Storm Drain Replacement
ADDRESS: Lake Drive
LOCATION: Cardiff, CA

SURFACE ELEVATION:
WATER ON COMPLETION: N/A
HAMMER WEIGHT: 35 lbs.
CONE AREA: 10 sq. cm

| DEPTH | BLOWS PER 10 cm | RESISTANCE Kg/cm² | GRAPH OF CONE RESISTANCE 0 50 100 150 | N' | TESTED CONSISTENCY NON-COHESIVE | COHESIVE |
|---|---|---|---|---|---|---|
| - | 6 | 26.6 | ••••••• | 7 | LOOSE | MEDIUM STIFF |
| - | 17 | 75.5 | •••••••••••••••••••• | 21 | MEDIUM DENSE | VERY STIFF |
| - 1 ft | 20 | 88.8 | •••••••••••••••••••••••• | 25 | MEDIUM DENSE | VERY STIFF |
| - | 50 | 222.0 | •••••••••••••••••••••••••••••••••••••••••••• | 25+ | VERY DENSE | HARD |
| - | 50 | 222.0 | •••••••••••••••••••••••••••••••••••••••••••• | 25+ | VERY DENSE | HARD |
| - 2 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 3 ft | | | | | | |
| - 1 m | | | | | | |
| - | | | | | | |
| - 4 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 5 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 6 ft | | | | | | |
| - | | | | | | |
| - 2 m | | | | | | |
| - 7 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 8 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 9 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 3 m 10 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 11 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 12 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 4 m 13 ft | | | | | | |

# WILDCAT DYNAMIC CONE LOG



NV5 West, Inc
15092 Ave of Science, Suite 200
San Diego, CA

PROJECT NUMBER: 226817-0000198.16
DATE STARTED: 01-18-2021
DATE COMPLETED: 01-18-2021

HOLE #: DC-7
CREW: Sean B., Adam H.
PROJECT: Lake Drive Storm Drain Replacement
ADDRESS: Lake Drive
LOCATION: Cardiff, CA

SURFACE ELEVATION:
WATER ON COMPLETION: N/A
HAMMER WEIGHT: 35 lbs.
CONE AREA: 10 sq. cm

| DEPTH | BLOWS PER 10 cm | RESISTANCE Kg/cm² | GRAPH OF CONE RESISTANCE 0 50 100 150 | N' | TESTED CONSISTENCY NON-COHESIVE | TESTED CONSISTENCY COHESIVE |
|---|---|---|---|---|---|---|
| - | 19 | 84.4 | •••••••••••••••••••••• | 24 | MEDIUM DENSE | VERY STIFF |
| - | 23 | 102.1 | ••••••••••••••••••••••••••• | 25+ | MEDIUM DENSE | VERY STIFF |
| - 1 ft | 13 | 57.7 | •••••••••••••••• | 16 | MEDIUM DENSE | VERY STIFF |
| - | 20 | 88.8 | •••••••••••••••••••••••• | 25 | MEDIUM DENSE | VERY STIFF |
| - | 20 | 88.8 | •••••••••••••••••••••••• | 25 | MEDIUM DENSE | VERY STIFF |
| - 2 ft | 19 | 84.4 | •••••••••••••••••••••• | 24 | MEDIUM DENSE | VERY STIFF |
| - | 16 | 71.0 | •••••••••••••••••• | 20 | MEDIUM DENSE | VERY STIFF |
| - | 15 | 66.6 | ••••••••••••••••• | 19 | MEDIUM DENSE | VERY STIFF |
| - 3 ft | 16 | 71.0 | •••••••••••••••••• | 20 | MEDIUM DENSE | VERY STIFF |
| - 1 m | 23 | 102.1 | ••••••••••••••••••••••••••• | 25+ | MEDIUM DENSE | VERY STIFF |
| - | 30 | 115.8 | •••••••••••••••••••••••••••••• | 25+ | DENSE | HARD |
| - 4 ft | 32 | 123.5 | •••••••••••••••••••••••••••••••• | 25+ | DENSE | HARD |
| - | 30 | 115.8 | •••••••••••••••••••••••••••••• | 25+ | DENSE | HARD |
| - | 40 | 154.4 | •••••••••••••••••••••••••••••••••••••••••••• | 25+ | DENSE | HARD |
| - 5 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 6 ft | | | | | | |
| - | | | | | | |
| - 2 m | | | | | | |
| - 7 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 8 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 9 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 3 m 10 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 11 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 12 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 4 m 13 ft | | | | | | |

# WILDCAT DYNAMIC CONE LOG



NV5 West, Inc
15092 Ave of Science, Suite 200
San Diego, CA

PROJECT NUMBER: 226817-0000198.16
DATE STARTED: 01-18-2021
DATE COMPLETED: 01-18-2021

HOLE #: DC-8
CREW: Sean B., Adam H.
PROJECT: Lake Drive Storm Drain Replacement
ADDRESS: Lake Drive
LOCATION: Cardiff, CA

SURFACE ELEVATION:
WATER ON COMPLETION: N/A
HAMMER WEIGHT: 35 lbs.
CONE AREA: 10 sq. cm

| DEPTH | BLOWS PER 10 cm | RESISTANCE Kg/cm² | GRAPH OF CONE RESISTANCE 0 50 100 150 | N' | TESTED CONSISTENCY NON-COHESIVE | COHESIVE |
|---|---|---|---|---|---|---|
| - | 23 | 102.1 | •••••••••••••••••••••••••• | 25+ | MEDIUM DENSE | VERY STIFF |
| - | 45 | 199.8 | •••••••••••••••••••••••••••••••••••••••••• | 25+ | VERY DENSE | HARD |
| - 1 ft | 50 | 222.0 | •••••••••••••••••••••••••••••••••••••••••• | 25+ | VERY DENSE | HARD |
| - | 48 | 213.1 | •••••••••••••••••••••••••••••••••••••••••• | 25+ | VERY DENSE | HARD |
| - | 43 | 190.9 | •••••••••••••••••••••••••••••••••••••••••• | 25+ | VERY DENSE | HARD |
| - 2 ft | 32 | 142.1 | ••••••••••••••••••••••••••••••••••••• | 25+ | DENSE | HARD |
| - | 24 | 106.6 | •••••••••••••••••••••••••• | 25+ | MEDIUM DENSE | VERY STIFF |
| - | 25 | 111.0 | •••••••••••••••••••••••••••• | 25+ | DENSE | HARD |
| - 3 ft | 16 | 71.0 | •••••••••••••••••• | 20 | MEDIUM DENSE | VERY STIFF |
| - 1 m | 13 | 57.7 | •••••••••••••••• | 16 | MEDIUM DENSE | VERY STIFF |
| - | 13 | 50.2 | •••••••••••••• | 14 | MEDIUM DENSE | STIFF |
| - 4 ft | 14 | 54.0 | •••••••••••••••• | 15 | MEDIUM DENSE | STIFF |
| - | 11 | 42.5 | •••••••••••• | 12 | MEDIUM DENSE | STIFF |
| - | 8 | 30.9 | •••••••• | 8 | LOOSE | MEDIUM STIFF |
| - 5 ft | 8 | 30.9 | •••••••• | 8 | LOOSE | MEDIUM STIFF |
| - | 8 | 30.9 | •••••••• | 8 | LOOSE | MEDIUM STIFF |
| - | 8 | 30.9 | •••••••• | 8 | LOOSE | MEDIUM STIFF |
| - 6 ft | 7 | 27.0 | ••••••• | 7 | LOOSE | MEDIUM STIFF |
| - | 7 | 27.0 | ••••••• | 7 | LOOSE | MEDIUM STIFF |
| - 2 m | 8 | 30.9 | •••••••• | 8 | LOOSE | MEDIUM STIFF |
| - 7 ft | 9 | 30.8 | •••••••• | 8 | LOOSE | MEDIUM STIFF |
| - | 10 | 34.2 | ••••••••• | 9 | LOOSE | STIFF |
| - | 9 | 30.8 | •••••••• | 8 | LOOSE | MEDIUM STIFF |
| - 8 ft | 9 | 30.8 | •••••••• | 8 | LOOSE | MEDIUM STIFF |
| - | 9 | 30.8 | •••••••• | 8 | LOOSE | MEDIUM STIFF |
| - | 8 | 27.4 | ••••••• | 7 | LOOSE | MEDIUM STIFF |
| - 9 ft | 10 | 34.2 | ••••••••• | 9 | LOOSE | STIFF |
| - | 50 | 171.0 | •••••••••••••••••••••••••••••••••••••••••• | 25+ | DENSE | HARD |
| - | | | | | | |
| - 3 m 10 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 11 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 12 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 4 m 13 ft | | | | | | |

# WILDCAT DYNAMIC CONE LOG



NV5 West, Inc
15092 Ave of Science, Suite 200
San Diego, CA

PROJECT NUMBER: 226817-0000198.16
DATE STARTED: 01-18-2021
DATE COMPLETED: 01-18-2021

HOLE #: DC-9
CREW: Sean B., Adam H.
PROJECT: Lake Drive Storm Drain Replacement
ADDRESS: Lake Drive
LOCATION: Cardiff, CA

SURFACE ELEVATION:
WATER ON COMPLETION: N/A
HAMMER WEIGHT: 35 lbs.
CONE AREA: 10 sq. cm

| DEPTH | BLOWS PER 10 cm | RESISTANCE Kg/cm² | GRAPH OF CONE RESISTANCE 0 50 100 150 | N' | TESTED CONSISTENCY NON-COHESIVE | COHESIVE |
|---|---|---|---|---|---|---|
| - | 5 | 22.2 | •••••• | 6 | LOOSE | MEDIUM STIFF |
| - | 8 | 35.5 | •••••••••• | 10 | LOOSE | STIFF |
| - 1 ft | 8 | 35.5 | •••••••••• | 10 | LOOSE | STIFF |
| - | 10 | 44.4 | ••••••••••• | 12 | MEDIUM DENSE | STIFF |
| - | 14 | 62.2 | •••••••••••••••••• | 17 | MEDIUM DENSE | VERY STIFF |
| - 2 ft | 14 | 62.2 | •••••••••••••••••• | 17 | MEDIUM DENSE | VERY STIFF |
| - | 15 | 66.6 | ••••••••••••••••••• | 19 | MEDIUM DENSE | VERY STIFF |
| - | 14 | 62.2 | •••••••••••••••••• | 17 | MEDIUM DENSE | VERY STIFF |
| - 3 ft | 18 | 79.9 | ••••••••••••••••••••••• | 22 | MEDIUM DENSE | VERY STIFF |
| - 1 m | 17 | 75.5 | ••••••••••••••••••••• | 21 | MEDIUM DENSE | VERY STIFF |
| - | 18 | 69.5 | ••••••••••••••••••• | 19 | MEDIUM DENSE | VERY STIFF |
| - 4 ft | 20 | 77.2 | ••••••••••••••••••••• | 22 | MEDIUM DENSE | VERY STIFF |
| - | 20 | 77.2 | ••••••••••••••••••••• | 22 | MEDIUM DENSE | VERY STIFF |
| - | 21 | 81.1 | ••••••••••••••••••••••• | 23 | MEDIUM DENSE | VERY STIFF |
| - 5 ft | 19 | 73.3 | •••••••••••••••••••• | 20 | MEDIUM DENSE | VERY STIFF |
| - | 20 | 77.2 | ••••••••••••••••••••• | 22 | MEDIUM DENSE | VERY STIFF |
| - | 22 | 84.9 | ••••••••••••••••••••••• | 24 | MEDIUM DENSE | VERY STIFF |
| - 6 ft | 21 | 81.1 | ••••••••••••••••••••••• | 23 | MEDIUM DENSE | VERY STIFF |
| - | 23 | 88.8 | •••••••••••••••••••••••• | 25 | MEDIUM DENSE | VERY STIFF |
| - 2 m | 22 | 84.9 | ••••••••••••••••••••••• | 24 | MEDIUM DENSE | VERY STIFF |
| - 7 ft | 22 | 75.2 | •••••••••••••••••••• | 21 | MEDIUM DENSE | VERY STIFF |
| - | 24 | 82.1 | ••••••••••••••••••••••• | 23 | MEDIUM DENSE | VERY STIFF |
| - | 22 | 75.2 | •••••••••••••••••••• | 21 | MEDIUM DENSE | VERY STIFF |
| - 8 ft | 24 | 82.1 | ••••••••••••••••••••••• | 23 | MEDIUM DENSE | VERY STIFF |
| - | 24 | 82.1 | ••••••••••••••••••••••• | 23 | MEDIUM DENSE | VERY STIFF |
| - | 22 | 75.2 | •••••••••••••••••••• | 21 | MEDIUM DENSE | VERY STIFF |
| - 9 ft | 23 | 78.7 | ••••••••••••••••••••• | 22 | MEDIUM DENSE | VERY STIFF |
| - | 24 | 82.1 | ••••••••••••••••••••••• | 23 | MEDIUM DENSE | VERY STIFF |
| - | 23 | 78.7 | ••••••••••••••••••••• | 22 | MEDIUM DENSE | VERY STIFF |
| - 3 m 10 ft | 25 | 85.5 | ••••••••••••••••••••••• | 24 | MEDIUM DENSE | VERY STIFF |
| - | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 11 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 12 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 4 m 13 ft | | | | | | |

# WILDCAT DYNAMIC CONE LOG



NV5 West, Inc
15092 Ave of Science, Suite 200
San Diego, CA

PROJECT NUMBER: 226817-0000198.16
DATE STARTED: 01-18-2021
DATE COMPLETED: 01-18-2021

HOLE #: DC-10
CREW: Sean B., Adam H.
PROJECT: Lake Drive Storm Drain Replacement
ADDRESS: Lake Drive
LOCATION: Cardiff, CA

SURFACE ELEVATION:
WATER ON COMPLETION: Wet at 10.5'
HAMMER WEIGHT: 35 lbs.
CONE AREA: 10 sq. cm

| DEPTH | BLOWS PER 10 cm | RESISTANCE Kg/cm² | GRAPH OF CONE RESISTANCE 0 50 100 150 | N' | TESTED CONSISTENCY NON-COHESIVE | TESTED CONSISTENCY COHESIVE |
|---|---|---|---|---|---|---|
| - | 5 | 22.2 | •••••• | 6 | LOOSE | MEDIUM STIFF |
| - | 5 | 22.2 | •••••• | 6 | LOOSE | MEDIUM STIFF |
| - 1 ft | 8 | 35.5 | •••••••••• | 10 | LOOSE | STIFF |
| - | 10 | 44.4 | •••••••••••• | 12 | MEDIUM DENSE | STIFF |
| - | 12 | 53.3 | •••••••••••••• | 15 | MEDIUM DENSE | STIFF |
| - 2 ft | 18 | 79.9 | •••••••••••••••••••••• | 22 | MEDIUM DENSE | VERY STIFF |
| - | 17 | 75.5 | •••••••••••••••••••• | 21 | MEDIUM DENSE | VERY STIFF |
| - | 22 | 97.7 | •••••••••••••••••••••••••• | 25+ | MEDIUM DENSE | VERY STIFF |
| - 3 ft | 22 | 97.7 | •••••••••••••••••••••••••• | 25+ | MEDIUM DENSE | VERY STIFF |
| - 1 m | 29 | 128.8 | •••••••••••••••••••••••••••••••••• | 25+ | DENSE | HARD |
| - | 26 | 100.4 | •••••••••••••••••••••••••• | 25+ | MEDIUM DENSE | VERY STIFF |
| - 4 ft | 38 | 146.7 | •••••••••••••••••••••••••••••••••••••••• | 25+ | DENSE | HARD |
| - | 40 | 154.4 | •••••••••••••••••••••••••••••••••••••••••• | 25+ | DENSE | HARD |
| - | | | | | | |
| - 5 ft | | | | | | |
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| - | | | | | | |
| - 6 ft | | | | | | |
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| - 2 m | | | | | | |
| - 7 ft | | | | | | |
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| - 11 ft | | | | | | |
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| - 12 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 4 m 13 ft | | | | | | |

# WILDCAT DYNAMIC CONE LOG



NV5 West, Inc
15092 Ave of Science, Suite 200
San Diego, CA

PROJECT NUMBER: 226817-0000198.16
DATE STARTED: 01-15-2021
DATE COMPLETED: 01-15-2021

HOLE #: DC-11
CREW: Sean B., Sean R.
PROJECT: Lake Drive Storm Drain Replacement
ADDRESS: Lake Drive
LOCATION: Cardiff, CA

SURFACE ELEVATION:
WATER ON COMPLETION: N/A
HAMMER WEIGHT: 35 lbs.
CONE AREA: 10 sq. cm

| DEPTH | BLOWS PER 10 cm | RESISTANCE Kg/cm² | GRAPH OF CONE RESISTANCE 0 50 100 150 | N' | TESTED CONSISTENCY NON-COHESIVE | TESTED CONSISTENCY COHESIVE |
|---|---|---|---|---|---|---|
| - | 6 | 26.6 | ••••••• | 7 | LOOSE | MEDIUM STIFF |
| - | 16 | 71.0 | •••••••••••••••••• | 20 | MEDIUM DENSE | VERY STIFF |
| - 1 ft | 31 | 137.6 | •••••••••••••••••••••••••••••••••••• | 25+ | DENSE | HARD |
| - | 50 | 222.0 | •••••••••••••••••••••••••••••••••••••••••• | 25+ | VERY DENSE | HARD |
| - | 50 | 222.0 | •••••••••••••••••••••••••••••••••••••••••• | 25+ | VERY DENSE | HARD |
| - 2 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 3 ft | | | | | | |
| - 1 m | | | | | | |
| - | | | | | | |
| - 4 ft | | | | | | |
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| - | | | | | | |
| - 5 ft | | | | | | |
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| - 6 ft | | | | | | |
| - | | | | | | |
| - 2 m | | | | | | |
| - 7 ft | | | | | | |
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| - 8 ft | | | | | | |
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| - | | | | | | |
| - 9 ft | | | | | | |
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| - | | | | | | |
| - 3 m 10 ft | | | | | | |
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| - | | | | | | |
| - 11 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 12 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 4 m 13 ft | | | | | | |

# WILDCAT DYNAMIC CONE LOG



NV5 West, Inc
15092 Ave of Science, Suite 200
San Diego, CA

PROJECT NUMBER: 226817-0000198.16
DATE STARTED: 01-15-2021
DATE COMPLETED: 01-15-2021

HOLE #: DC-12
CREW: Sean B., Sean R.
PROJECT: Lake Drive Storm Drain Replacement
ADDRESS: Lake Drive
LOCATION: Cardiff, CA

SURFACE ELEVATION:
WATER ON COMPLETION: N/A
HAMMER WEIGHT: 35 lbs.
CONE AREA: 10 sq. cm

| DEPTH | BLOWS PER 10 cm | RESISTANCE Kg/cm² | GRAPH OF CONE RESISTANCE 0 50 100 150 | N' | TESTED CONSISTENCY NON-COHESIVE | TESTED CONSISTENCY COHESIVE |
|---|---|---|---|---|---|---|
| - | 13 | 57.7 | •••••••••••••••• | 16 | MEDIUM DENSE | VERY STIFF |
| - | 50 | 222.0 | •••••••••••••••••••••••••••••••••••••••••• | 25+ | VERY DENSE | HARD |
| - 1 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 2 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 3 ft | | | | | | |
| - 1 m | | | | | | |
| - | | | | | | |
| - 4 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 5 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 6 ft | | | | | | |
| - | | | | | | |
| - 2 m | | | | | | |
| - 7 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 8 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 9 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 3 m 10 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 11 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 12 ft | | | | | | |
| - | | | | | | |
| - | | | | | | |
| - 4 m 13 ft | | | | | | |

# APPENDIX B

Laboratory Test Results

# LABORATORY TEST RESULTS

## In-situ Moisture Tests

The in-situ moisture contents of selected samples obtained from the exploratory borings were evaluated in general accordance with the latest versions of ASTM D2216 laboratory test methods. The methods involve obtaining the moist weight of the sample and then drying the sample to obtain its dry weight. The moisture content is calculated by taking the difference between the wet and dry weights, dividing it by the dry weight of the sample and expressing the result as a percentage. The results of the in-situ moisture content tests are presented in the following table and on the logs of exploratory borings in Appendix A.

RESULTS OF MOISTURE CONTENT TESTS
(ASTM D2216)

| Sample Location / Depth (ft.) | Moisture Content (percent) |
|---|---|
| HAB–1 @ 6.5 – 7 | 4.7 |
| HAB–1 @ 2 – 5 | 8.2 |
| HAB–2 @ 3 – 3.5 | 8.2 |
| HAB–2 @ 5 – 5.5 | 7.6 |
| HAB–2 @ 7 – 7.5 | 6.1 |
| HAB–3 @ 3 – 3.5 | 4.5 |
| HAB–4 @ 3 – 3.5 | 6.1 |
| HAB–4 @ 4.5 – 5 | 6.9 |
| HAB–5 @ 3 – 3.5 | 6.9 |
| HAB–6 @ 3 – 3.5 | 2.7 |
| HAB–6 @ 4.5 – 5 | 3.5 |
| HAB–7 @ 3 – 3.5 | 5.4 |
| HAB–8 @ 3 – 7 | 12.7 |
| HAB–8 @ 6 – 6.5 | 16.3 |
| HAB–9 @ 2.5 – 3 | 3.5 |
| HAB–9 @ 12 – 12.5 | 6.8 |
| HAB–10 @ 4 – 6 | 10.1 |
| HAB–11 @ 3 – 5 | 7.0 |

## Classification

Soils were visually and texturally classified in accordance with the Unified Soil Classification System (USCS/ASTM D2487) and ASTM D2488. Soil classifications are indicated on the logs of the exploratory borings presented in Appendix A.

## Particle-size Distribution Tests

An evaluation of the grain-size distribution of selected soil samples was performed in general accordance with the latest version of ASTM D6913. These test results were utilized in evaluating the soil classifications in accordance with the Unified Soil Classification System. Particle size distribution test results are presented on the laboratory test sheets attached in this appendix.

## Laboratory Compaction Characteristics Tests

Compaction characteristic tests were performed on the bulk-disturbed representative soil samples in general accordance with the latest version of ASTM D1557 laboratory test methods. The test establishes the laboratory maximum dry density and optimum moisture content of the tested soils and are also used to aid in evaluating the strength characteristics of the soils. The results of the tests are presented below and attached in this appendix.

**RESULTS OF COMPACTION CHARACTERISTICS TESTS**
**(ASTM D1557)**

| Sample Location / Depth (ft.) | HAB-1 @ 2 – 5 | HAB-8 @ 3 – 7 |
|---|---|---|
| Material Classification (USCS) | Silty SAND (SM) | Silty SAND (SM) |
| Maximum Dry Density (pcf) | 122.7 | 123.3 |
| Optimum Moisture Content (%) | 10.7 | 11.1 |

## Expansion Index Test

An expansion index test was performed on a bulk-disturbed representative sample of the on-site materials encountered. The tests were performed in general accordance with ASTM D4829. The test result is summarized below and attached in this appendix.

**RESULTS OF EXPANSION INDEX TEST**
**(ASTM D4829)**

| Sample Location & Depth (ft.) | Material Type (USCS) | Initial Moisture Content (%) | Final Moisture Content (%) | Dry Density (pcf) | Initial Saturation (%) | Expansion Index | Potential Expansion |
|---|---|---|---|---|---|---|---|
| HAB-8 @ 3 – 7 | Silty SAND (SM) | 10.0 | 17.3 | 109.7 | 50.5 | 1 | VERY LOW |

## Direct Shear Tests

Direct shear tests were performed on representative samples in general accordance with ASTM D3080 to evaluate the shear strength characteristics of the on-site materials. The test specimens were remolded to 90% of their maximum dry density. The test method consists of placing the remolded specimens in the direct shear device, applying a series of normal stresses, saturating the sample, and then shearing the sample at the constant rate of shearing deformation under drained conditions. The shearing force and horizontal displacements are measured and recorded as the soil specimen is sheared. The shearing is continued well beyond the point of maximum stress until the stress reaches a constant or residual value. The results of the tests are presented in the following table and attached in this appendix.

**RESULTS OF DIRECT SHEAR TESTS**
**(ASTM D3080)**

| Location / Depth (ft.) | USCS Classification | Peak Friction (degrees) | Ultimate Friction (degrees) | Peak Cohesion (psf) | Ultimate Cohesion (psf) | Notes |
|---|---|---|---|---|---|---|
| HAB-1 @ 2 – 5 | Silty SAND (SM) | 33 | 31 | 107 | 0 | Remolded to about 90% of maximum dry density |
| HAB-8 @ 3 – 7 | Silty SAND (SM) | 36 | 32 | 0 | 0 | Remolded to about 90% of maximum dry density |

## Soil Corrosivity Tests

Water soluble sulfate & chloride, resistivity and pH tests were performed by Clarkson Laboratory and Supply Inc., in general accordance with California Test Methods 643, 417 and 422 to provide an indication of the degree of corrosivity of the subgrade soils at locations tested with regard to concrete and normal grade steel.

**RESULTS OF CORROSIVITY TESTS**
**(CTM 417, CTM 422 and CTM 643)**

| Sample Location & Depth (ft.) | USCS Classification | pH | Minimum Resistivity (Ohm-cm) | Water Soluble Sulfates (ppm) | Water Soluble Chlorides (ppm) |
|---|---|---|---|---|---|
| HAB-1 @ 2 – 5 | Silty SAND (SM) | 7.0 | 640 | 81 | 480 |
| HAB-8 @ 3 – 7 | Silty SAND (SM) | 7.2 | 2200 | 39 | 75 |

**In-Situ Moisture Report**
(ASTM D2216)

| | | | |
|---|---|---|---|
| Date: | 2/11/2021 | Job Number: | 226817-0000198.16 |
| Client: | City of Encinitas | Report Number: | 8313 |
| Client Address: | 505 South Vulcan Avenue, Encinitas, CA | Lab Number: | 121038-121055 |
| Project Name: | Lake Drive Storm Drain Improvements | | |
| Project Address: | Encinitas, CA | | |
| Date Sampled: | 1/18/2021 | Sampled By: | Geo Team |
| Date Recieved: | 1/19/2021 | Submitted By: | Geo Team |

| Lab Number | 121038 | 121039 | 121040 | 121041 | 121042 |
|---|---|---|---|---|---|
| Exploration No. | HAB-1 | HAB-1 | HAB-2 | HAB-2 | HAB-2 |
| Depth, ft. | 6.5-7 | 2-5 | 3-3.5 | 5-5.5 | 7-7.5 |
| Mositure Content, % | 4.7 | 8.2 | 8.2 | 7.6 | 6.1 |

| Lab Number | 121043 | 121044 | 121045 | 121046 | 121047 |
|---|---|---|---|---|---|
| Exploration No. | HAB-3 | HAB-4 | HAB-4 | HAB-5 | HAB-6 |
| Depth, ft. | 3-3.5 | 3-3.5 | 4.5-5 | 3-3.5 | 3-3.5 |
| Mositure Content, % | 4.5 | 6.1 | 6.9 | 6.9 | 2.7 |

| Lab Number | 121048 | 121049 | 121050 | 121051 | 121052 |
|---|---|---|---|---|---|
| Exploration No. | HAB-6 | HAB-7 | HAB-8 | HAB-8 | HAB-9 |
| Depth, ft. | 4.5-5 | 3-3.5 | 6-6.5 | 3-7 | 2.5-3 |
| Mositure Content, % | 3.5 | 5.4 | 16.3 | 12.7 | 3.5 |

| Lab Number | 121053 | 121054 | 121055 | | |
|---|---|---|---|---|---|
| Exploration No. | HAB-9 | HAB-10 | HAB-11 | | |
| Depth, ft. | 12-12.5 | 4-6 | 3-5 | | |
| Mositure Content, % | 6.8 | 10.1 | 7.0 | | |

Respectfully Submitted,
**NV5 West, Inc.**

Carl Henderson, PhD, PE, GE
CDO / SoCal CQA Group Director

**Expansion Index Test Report**
(ASTM D4829)

| | | | |
|---|---|---|---|
| Date: | 2/11/2021 | | |
| Client: | City of Encinitas | | |
| Client Address: | 505 South Vulcan Avenue, Encinitas, CA | Job Number: | 226817-0000198.16 |
| Project Name: | Lake Drive Storm Drain Improvements | Report Number: | 8313 |
| Project Address: | Encinitas, CA | Lab Number: | 121051 |
| Date Sampled | 1/18/2021 | Sampled By: | Geo Team |
| Date Submitted: | 1/19/2021 | Submitted By: | Geo Team |

| | | | | |
|---|---|---|---|---|
| Lab Number | 121051 | | | |
| Material Location | HAB-8 @ 5'-7' | | | |
| Material Type | Brown Silty SAND (SM) | | | |
| Material Source | Onsite | | | |
| Initial Moisture Content, % | 10.0 | | | |
| Final Moisture Content, % | 17.3 | | | |
| Dry Density, pcf | 109.7 | | | |
| Initial Saturation, % | 50.5 | | | |
| Initial Dial Reading | 0.510 | | | |
| Final Dial Reading | 0.511 | | | |
| Expansion Index | 1 | | | |
| Potential Expansion | **Very Low** | | | |

Respectfully Submitted,
**NV5 West, Inc.**

Carl Henderson, PhD, PE, GE
CDO / SoCal CQA Group Director

# REPORT OF SIEVE ANALYSIS TEST

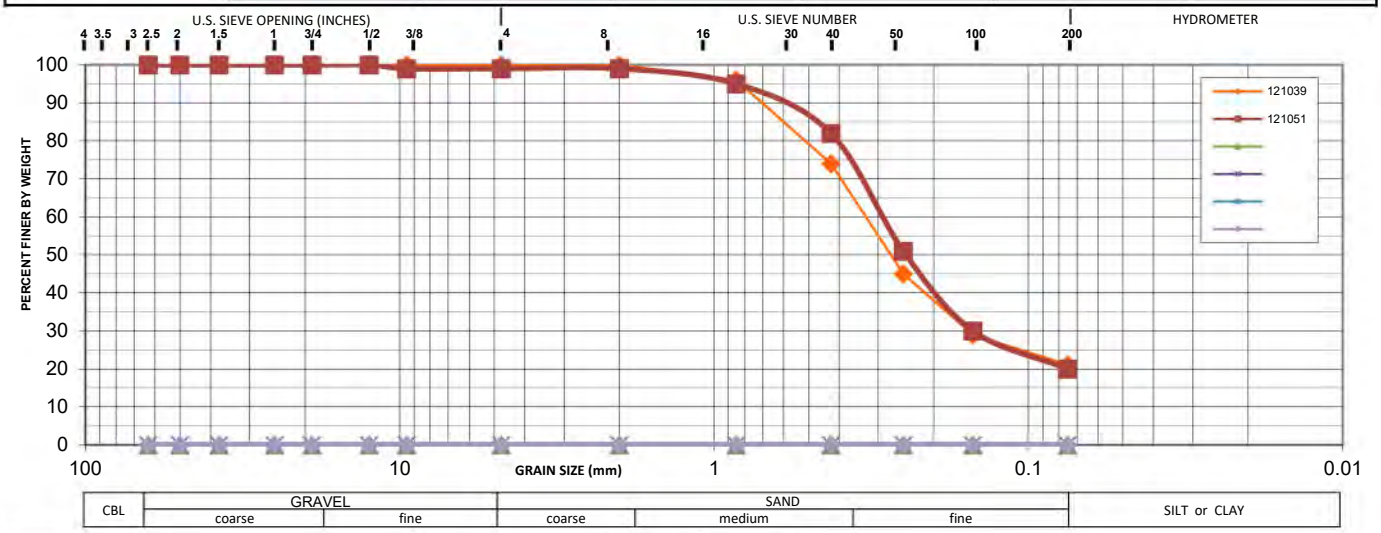
ASTM D6913 - Soil

Date: March 1, 2021
Client: City of Encinitas
Address: 505 South Vulcan Avenue, Encinitas, CA

Job Number: 226817-0000198.16
Report No.: 8313
Lab Number: 121039 & 121051
Sampled By: Geo Team
Submitted By: Geo Team

Project : Lake Drive Storm Drain Improvements
Project Address: Encinitas, CA
Date Sampled: 1/18/2021
Date Submitted: 1/19/2021

| | 121039 | 121051 | | | | |
|---|---|---|---|---|---|---|
| Material | Brown Silty SAND (SM) | Brown Silty SAND (SM) | | | | |
| Source | Onsite | Onsite | | | | |
| Sample Location | HAB-1 @ 2'-5' | HAB-8 @ 3'-7' | | | | |
| Date Tested | 1/22/2021 | 1/22/2021 | | | | |
| Tested By | Tony Echeverria | Tony Echeverria | | | | |




| Sample ID: | 121039 | 121051 | | | | |
|---|---|---|---|---|---|---|
| Sieve Size | % Passing | | | | | |
| 63mm (2 1/2") | 100 | 100 | | | | |
| 50mm (2") | 100 | 100 | | | | |
| 37.5mm (1 1/2") | 100 | 100 | | | | |
| 25mm (1") | 100 | 100 | | | | |
| 19mm (3/4") | 100 | 100 | | | | |
| 12.5mm (1/2") | 100 | 100 | | | | |
| 9.5mm (3/8") | 100 | 99 | | | | |
| 4.75mm (#4) | 100 | 99 | | | | |
| 2mm (#10) | 100 | 99 | | | | |
| 850µm (#20) | 96 | 95 | | | | |
| 425µm (#40) | 74 | 82 | | | | |
| 250µm (#60) | 45 | 51 | | | | |
| 150 µm (#100) | 29 | 30 | | | | |
| 75 um (#200) washµ | 21.1 | 20.0 | | | | |
| Coef. of Curvature ($C_C$) | NR | NR | | | | |
| Coef. of Uniformity ($C_U$) | NR | NR | | | | |
| % Gravel | 0 | 1 | | | | |
| % Sand | 79 | 79 | | | | |
| % Fines | 21.1 | 20.0 | | | | |
| USCS Class: | SM | SM | | | | |

Respectfully Submitted,
**NV5 West, Inc.**

Carl Henderson, PhD, PE, GE
CDO / SoCal CQA Group Director

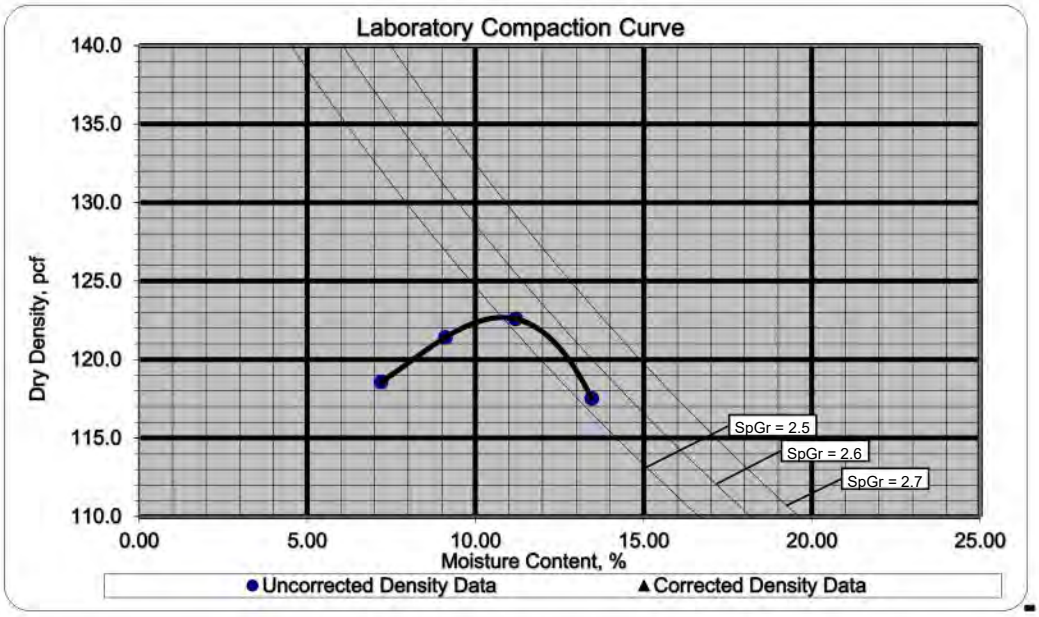
# Report of Moisture/Density Relationship Test

(ASTM D1557)

| | | | |
|---|---|---|---|
| Date: | 3/2/2021 | | |
| Client: | City of Encinitas | | |
| Client Address: | 505 South Vulcan Avenue, Encinitas, CA | Job Number: | 226817-0198.16 |
| Project Name: | Lake Drive Storm Drain Improvements | Report Number: | 8313 |
| Project Address: | Encinitas, CA | Lab Number: | 121039 |
| Date Sampled: | 01/18/21 | Sampled By: | Geo Team |
| Date Submitted: | 01/19/21 | Submitted By: | Geo Team |
| Sample Location: | B1 @ 2'-5' | Test Designation: | ASTM_D1557 |
| Material Description: | Brown Silty SAND (SM) | Method: | A |
| Material Source: | On-Site | Method of Sample Preparation: | Dry |
| Oversize Correction? | No | Type of Hammer Used: | Automatic |

Sieve Results (Retained %): Curve Number: 1

3/4": 0 3/8": 0 #4: 0




Respectfully Submitted,

**NV5 West, Inc.**

Carl Henderson, PhD, PE, GE

CDO / SoCal CQA Group Director

| Test Results | |
|---|---|
| Maximum Density, pcf | **122.7** |
| Optimum Moisture, % | **10.7** |

| Oversize Corrected Results | |
|---|---|
| Maximum Density, pcf | **N/A** |
| Optimum Moisture, % | **N/A** |

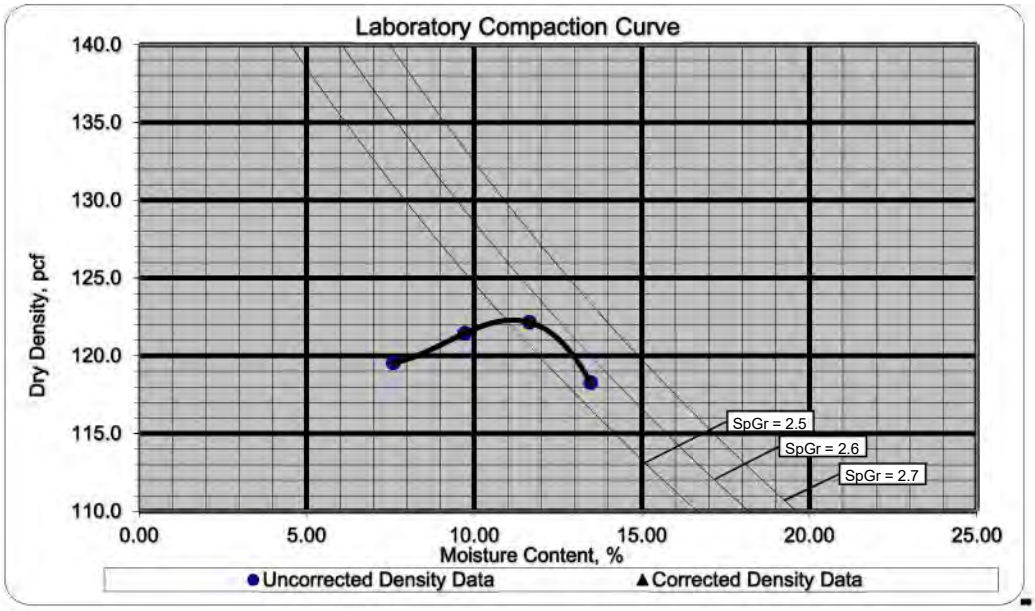
# Report of Moisture/Density Relationship Test

(ASTM D1557)

| | | | |
|---|---|---|---|
| Date: | 2/11/2021 | | |
| Client: | City of Encinitas | | |
| Client Address: | 505 South Vulcan Avenue, Encinitas, CA | Job Number: | 226817-0198.16 |
| Project Name: | Lake Drive Storm Drain Improvements | Report Number: | 8313 |
| Project Address: | Encinitas, CA | Lab Number: | 121051 |
| Date Sampled: | 01/18/21 | Sampled By: | Geo Team |
| Date Submitted: | 01/19/21 | Submitted By: | Geo Team |
| Sample Location: | B8 @ 3'-7' | Test Designation: | ASTM_D1557 |
| Material Description: | Brown Silty SAND (SM) | Method: | A |
| Material Source: | On-Site | Method of Sample Preparation: | Dry |
| Oversize Correction? | No | Type of Hammer Used: | Automatic |

Sieve Results (Retained %): Curve Number: 2

3/4": 0 3/8": 1 #4: 1




Respectfully Submitted,

**NV5 West, Inc.**

Carl Henderson, PhD, PE, GE

CDO / Socal CQA Director

| Test Results | |
|---|---|
| Maximum Density, pcf | **122.3** |
| Optimum Moisture, % | **11.1** |

| Oversize Corrected Results | |
|---|---|
| Maximum Density, pcf | **N/A** |
| Optimum Moisture, % | **N/A** |

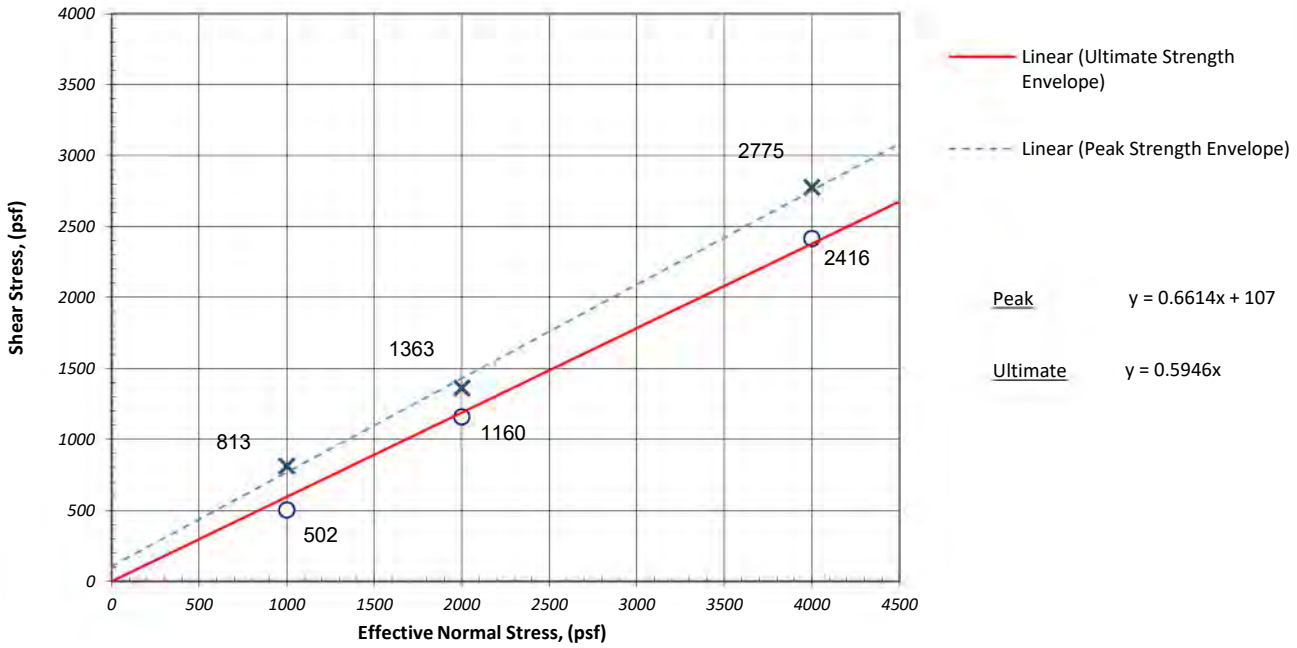
# DIRECT SHEAR TEST (ASTM D3080)

| | | | | | |
|---|---|---|---|---|---|
| Project No. | **226817-0000198.16** | | | Date: | **2/2/2021** |
| Client: | **City of Encinitas** | | | Report No.: | **8313** |
| Proj. Name: | **Lake Drive Storm Drain Improvements** | | | Lab No.: | **121039** |
| Location: | **Encinitas, CA** | | | Date Rcvd: | **1/19/2021** |
| Sample date: | **1/18/2021** | Sample Location: | **2'-5'** | Boring No. **HAB-1** | Test Date: **1/29/2021** |

**TEST DATA:**

| Normal Stress, (ksf) | | 1 ksf | 2 ksf | 4 ksf |
|---|---|---|---|---|
| Initial | Water Content (%) | 15.2 | 15.2 | 15.2 |
| | Dry Density | 110.8 | 110.5 | 110.9 |
| | Saturation (%) | 63.2 | 62.8 | 63.3 |
| Final | Water Content (%) | 19.4 | 18.9 | 18.6 |
| | Dry Density | 111.6 | 112.1 | 112.2 |
| | Saturation (%) | 82.1 | 80.9 | 79.7 |
| Normal Stress (psf) | | 1000 | 2000 | 4000 |
| Ultimate Shear Stress (psf) | | 502 | 1160 | 2416 |
| Peak Shear Stress (psf) | | 813 | 1363 | 2775 |

| | |
|---|---|
| Sample Type: | Remolded Sample to about 90% of Optimal Density |
| Description: | Silty SAND (SM) |
| Color: | Brown |
| Tested By: | Chirag Padhiar |




| | |
|---|---|
| Peak Cohesion, C'(psf): 107 | Ultimate Cohesion, C'(psf): **0** |
| Peak Friction,Φ' (deg): **33** | Ultimate Friction,Φ' (deg): **31** |


**NV5**
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San Diego CA 92128
p. 858 385 0500 f. 858 715 5810


**Respectfully Submitted,**

**NV5 West, Inc.**


Carl Henderson, PhD, PE, GE
CDO / SoCal CQA Group Director

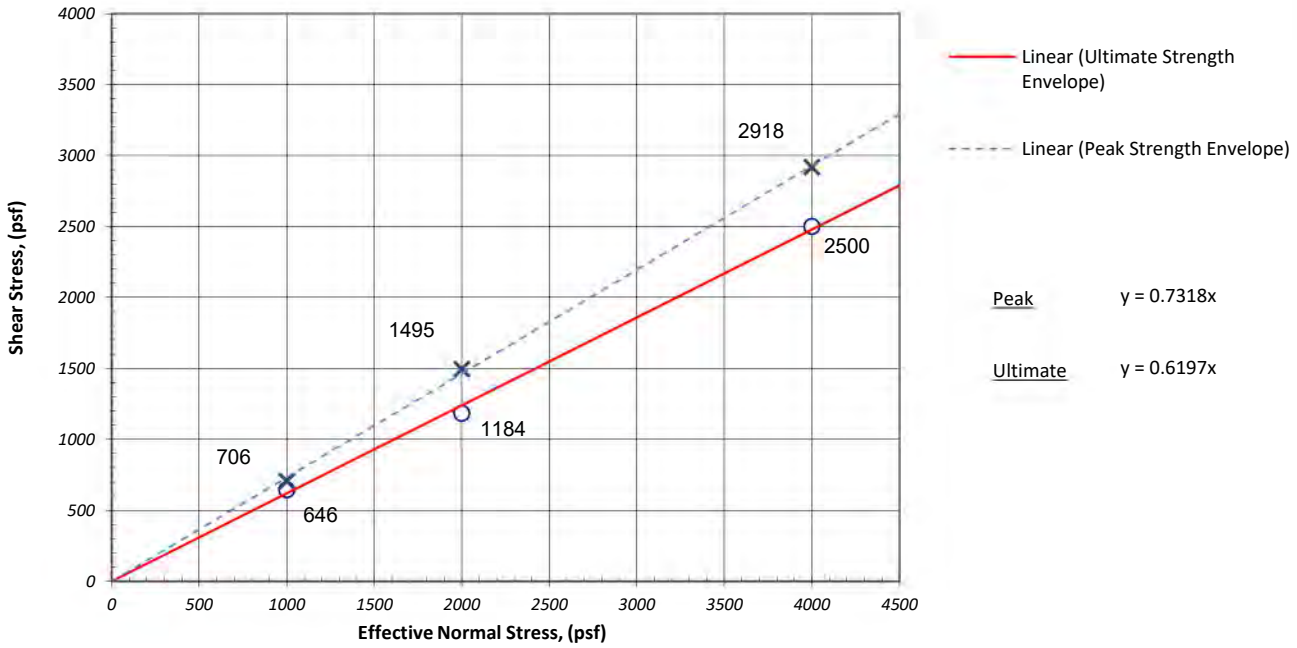
# DIRECT SHEAR TEST (ASTM D3080)

| | | | | | |
|---|---|---|---|---|---|
| Project No. | **226817-0000198.16** | | | Date: | **2/2/2021** |
| Client: | **City of Encinitas** | | | Report No.: | **8313** |
| Proj. Name: | **Lake Drive Storm Drain Improvements** | | | Lab No.: | **121051** |
| Location: | **Encinitas, CA** | | | Date Rcvd: | **1/19/2021** |
| Sample date: | **1/18/2021** | Sample Location: | **3'-7'** | Boring No. **HAB-8** | Test Date: **2/1/2021** |

**TEST DATA:**

| Normal Stress, (ksf) | | 1 ksf | 2 ksf | 4 ksf |
|---|---|---|---|---|
| Initial | Water Content (%) | 14.2 | 14.2 | 14.2 |
| | Dry Density | 109.8 | 110.2 | 110.1 |
| | Saturation (%) | 63.6 | 64.1 | 64.0 |
| Final | Water Content (%) | 19.4 | 15.6 | 18.2 |
| | Dry Density | 111.1 | 113.5 | 110.5 |
| | Saturation (%) | 89.5 | 76.2 | 82.8 |
| Normal Stress (psf) | | 1000 | 2000 | 4000 |
| Ultimate Shear Stress (psf) | | 646 | 1184 | 2500 |
| Peak Shear Stress (psf) | | 706 | 1495 | 2918 |

| | |
|---|---|
| Sample Type: | Remolded Sample to about 90% of Optimal Density |
| Description: | Silty SAND (SM) |
| Color: | Brown |
| Tested By: | Chirag Padhiar |




| | |
|---|---|
| Peak Cohesion, C'(psf): **0** | Ultimate Cohesion, C'(psf): **0** |
| Peak Friction,Φ' (deg): **36** | Ultimate Friction,Φ' (deg): **32** |


**NV5**
15092 Avenue of Science, Ste 200
San Diego CA 92128
p. 858 385 0500 f. 858 715 5810


**Respectfully Submitted,**

**NV5 West, Inc.**


Carl Henderson, PhD, PE, GE
CDO / SoCal CQA Group Director

# L A B O R A T O R Y  R E P O R T

Telephone (619) 425-1993  Fax 425-7917  Established 1928

C L A R K S O N  L A B O R A T O R Y  A N D  S U P P L Y  I N C.
350 Trousdale Dr. Chula Vista, Ca. 91910 www.clarksonlab.com
A N A L Y T I C A L  A N D  C O N S U L T I N G  C H E M I S T S

Date: January 29, 2021
Purchase Order Number: 21-0617
Sales Order Number: 50574
Account Number: NV5.SD

To:
*------------------------------------------------*
NV5 West Inc
15092 Avenue of Science #200
San Diego, CA 92128
Attention: Michelle Albrecht

Laboratory Number: SO8101-1  Customers Phone: 858-715-5800
Fax: 858-715-5810
Sample Designation:
*------------------------------------------------*
One soil sample received on 01/27/21 at 1:55pm,
taken from Job# Lake Drive Strom Drain Improvements
Project 226817-0000198.16 marked as Lab No 121039,
Report No 8313 Loc:B1@2'-5'

Analysis By California Test 643, 1999, Department of Transportation
Division of Construction, Method for Estimating the Service Life of
Steel Culverts.

pH 7.0

| Water Added (ml) | Resistivity (ohm-cm) |
|---|---|
| 10 | 2700 |
| 5 | 1300 |
| 5 | 890 |
| 5 | 670 |
| 5 | 640 |
| 5 | 680 |
| 5 | 740 |

18 years to perforation for a 16 gauge metal culvert.
24 years to perforation for a 14 gauge metal culvert.
33 years to perforation for a 12 gauge metal culvert.
42 years to perforation for a 10 gauge metal culvert.
51 years to perforation for a  8 gauge metal culvert.

Water Soluble Sulfate  Calif. Test 417  0.008% (81ppm)

Water Soluble Chloride Calif. Test 422  0.048% (480ppm)

Rosa Bernal
RMB/js

# L A B O R A T O R Y  R E P O R T

Telephone (619) 425-1993  Fax 425-7917  Established 1928

C L A R K S O N  L A B O R A T O R Y  A N D  S U P P L Y  I N C.
350 Trousdale Dr. Chula Vista, Ca. 91910 www.clarksonlab.com
A N A L Y T I C A L  A N D  C O N S U L T I N G  C H E M I S T S

Date: January 29, 2021
Purchase Order Number: 21-0617
Sales Order Number: 50574
Account Number: NV5.SD

To:
*------------------------------------------------*
NV5 West Inc
15092 Avenue of Science #200
San Diego, CA 92128
Attention: Michelle Albrecht

Laboratory Number: SO8101-2  Customers Phone: 858-715-5800
Fax: 858-715-5810
Sample Designation:
*------------------------------------------------*
One soil sample received on 01/27/21 at 1:55pm,
taken from Job# Lake Drive Strom Drain Improvements
Project 226817-0000198.16 marked as Lab No 121051,
Report No 8313 Loc:B8@3'-7'

Analysis By California Test 643, 1999, Department of Transportation
Division of Construction, Method for Estimating the Service Life of
Steel Culverts.

pH 7.2

| Water Added (ml) | Resistivity (ohm-cm) |
|---|---|
| 10 | 3500 |
| 5 | 2900 |
| 5 | 2300 |
| 5 | 2200 |
| 5 | 2200 |
| 5 | 2400 |
| 5 | 2700 |

33 years to perforation for a 16 gauge metal culvert.
43 years to perforation for a 14 gauge metal culvert.
60 years to perforation for a 12 gauge metal culvert.
77 years to perforation for a 10 gauge metal culvert.
94 years to perforation for a  8 gauge metal culvert.

Water Soluble Sulfate  Calif. Test 417  0.004% (39ppm)

Water Soluble Chloride Calif. Test 422  0.008% (75ppm)

Rosa Bernal
RMB/js

# APPENDIX C

Typical Earthwork Guidelines

# TYPICAL EARTHWORK GUIDELINES

## 1. GENERAL

These guidelines and the standard details attached hereto are presented as general procedures for earthwork construction for sites having slopes less than 10 feet high. They are to be utilized in conjunction with the project grading plans. These guidelines are considered a part of the geotechnical report, but are superseded by recommendations in the geotechnical report in the case of conflict. Evaluations performed by the consultant during the course of grading may result in new recommendations which could supersede these specifications and/or the recommendations of the geotechnical report. It is the responsibility of the contractor to read and understand these guidelines as well as the geotechnical report and project grading plans.

1.1. The contractor shall not vary from these guidelines without prior recommendations by the geotechnical consultant and the approval of the client or the client's authorized representative. Recommendations by the geotechnical consultant and/or client shall not be considered to preclude requirements for approval by the jurisdictional agency prior to the execution of any changes.

1.2. The contractor shall perform the grading operations in accordance with these specifications, and shall be responsible for the quality of the finished product notwithstanding the fact that grading work will be observed and tested by the geotechnical consultant.

1.3. It is the responsibility of the grading contractor to notify the geotechnical consultant and the jurisdictional agencies, as needed, prior to the start of work at the site and at any time that grading resumes after interruption. Each step of the grading operations shall be observed and documented by the geotechnical consultant and, where needed, reviewed by the appropriate jurisdictional agency prior to proceeding with subsequent work.

1.4. If, during the grading operations, geotechnical conditions are encountered which were not anticipated or described in the geotechnical report, the geotechnical consultant shall be notified immediately and additional recommendations, if applicable, may be provided.

1.5. An as-graded report shall be prepared by the geotechnical consultant and signed by a registered engineer and registered engineering geologist. The report documents the geotechnical consultants' observations, and field and laboratory test results, and provides conclusions regarding whether or not earthwork construction was performed in accordance with the geotechnical recommendations and the grading plans. Recommendations for foundation design, pavement design, subgrade treatment, etc., may also be included in the as-graded report.

1.6. For the purpose of evaluating quantities of materials excavated during grading and/or locating the limits of excavations, a licensed land surveyor or civil engineer shall be retained.

## 2. SITE PREPARATION

Site preparation shall be performed in accordance with the recommendations presented in the following sections.

2.1. The client, prior to any site preparation or grading, shall arrange and attend a pre-grading meeting between the grading contractor, the design engineer, the geotechnical consultant, and representatives of appropriate governing authorities, as well as any other involved parties. The parties shall be given two working days notice.

2.2. Clearing and grubbing shall consist of the substantial removal of vegetation, brush, grass, wood, stumps, trees, tree roots greater than 1/2-inch in diameter, and other deleterious materials from the areas to be graded. Clearing and grubbing shall extend to the outside of the proposed excavation and fill areas.

2.3. Demolition in the areas to be graded shall include removal of building structures, foundations, reservoirs, utilities (including underground pipelines, septic tanks, leach fields, seepage pits, cisterns, etc.), and other manmade surface and subsurface improvements, and the backfilling of mining shafts, tunnels and surface depressions. Demolition of utilities shall include capping or rerouting of pipelines at the project perimeter, and abandonment of wells in accordance with the requirements of the governing authorities and the recommendations of the geotechnical consultant at the time of demolition.

2.4. The debris generated during clearing, grubbing and/or demolition operations shall be removed from areas to be graded and disposed of off site at a legal dump site. Clearing, grubbing, and demolition operations shall be performed under the observation of the geotechnical consultant.

2.5. The ground surface beneath proposed fill areas shall be stripped of loose or unsuitable soil. These soils may be used as compacted fill provided they are generally free of organic or other deleterious materials and evaluated for use by the geotechnical consultant. The resulting surface shall be evaluated by the geotechnical consultant prior to proceeding. The cleared, natural ground surface shall be scarified to a depth of approximately 8 inches, moisture conditioned, and compacted in accordance with the specifications presented in Section 4 of these guidelines.

## 3. REMOVALS AND EXCAVATIONS

Removals and excavations shall be performed as recommended in the following sections.

3.1. Removals

3.1.1. Materials which are considered unsuitable shall be excavated under the observation of the geotechnical consultant in accordance with the recommendations contained herein. Unsuitable materials include, but may not be limited to, dry, loose, soft, wet, organic, compressible natural soils, fractured, weathered, soft bedrock, and undocumented or otherwise deleterious fill materials.

3.1.2. Materials deemed by the geotechnical consultant to be unsatisfactory due to moisture conditions shall be excavated in accordance with the recommendations of the geotechnical consultant, watered or dried as needed, and mixed to generally uniform moisture content in accordance with the specifications presented in Section 4 of this document.

3.2. Excavations

3.2.1. Temporary excavations no deeper than 4 feet in firm fill or natural materials may be made with vertical side slopes. To satisfy California Occupational Safety and Health Administration (Cal OSHA) requirements, any excavation deeper than 4 feet shall be shored or laid back at a 1:1 inclination or flatter, depending on material type, if construction workers are to enter the excavation.

## 4. COMPACTED FILL

Fill shall be constructed as specified below or by other methods recommended by the geotechnical consultant. Unless otherwise specified, fill soils shall be compacted to 90 percent relative compaction, as evaluated in accordance with ASTM Test Method D 1557.

4.1. Prior to placement of compacted fill, the contractor shall request an evaluation of the exposed ground surface by the geotechnical consultant. Unless otherwise recommended, the exposed ground surface shall then be scarified to a depth of approximately 8 inches and watered or dried, as needed, to achieve a generally uniform moisture content at or near the optimum moisture content. The scarified materials shall then be compacted to 90 percent relative compaction. The evaluation of compaction by the geotechnical consultant shall not be considered to preclude any requirements for observation or approval by governing agencies. It is the contractor's responsibility to notify the geotechnical consultant and the appropriate governing agency when project areas are ready for observation, and to provide reasonable time for that review.

4.2. Excavated on-site materials which are in general compliance with the recommendations of the geotechnical consultant may be utilized as compacted fill provided they are generally free of organic or other deleterious materials and do not contain rock fragments greater than 6 inches in dimension. During grading, the contractor may encounter soil types other than those analyzed during the geotechnical study. The geotechnical consultant shall be consulted to evaluate the suitability of any such soils for use as compacted fill.

4.3. Where imported materials are to be used on site, the geotechnical consultant shall be notified three working days in advance of importation in order that it may sample and test the materials from the proposed borrow sites. No imported materials shall be delivered for use on site without prior sampling, testing, and evaluation by the geotechnical consultant.

4.4. Soils imported for on-site use shall preferably have very low to low expansion potential (based on UBC Standard 18-2 test procedures). Lots on which expansive soils may be exposed at grade shall be undercut 3 feet or more and capped with very low to low expansion potential fill. In the event expansive soils are present near the ground surface, special design and construction considerations shall be utilized in general accordance with the recommendations of the geotechnical consultant.

4.5. Fill materials shall be moisture conditioned to near optimum moisture content prior to placement. The optimum moisture content will vary with material type and other factors. Moisture conditioning of fill soils shall be generally uniform in the soil mass.

4.6. Prior to placement of additional compacted fill material following a delay in the grading operations, the exposed surface of previously compacted fill shall be prepared to receive fill. Preparation may include scarification, moisture conditioning, and recompaction.

4.7. Compacted fill shall be placed in horizontal lifts of approximately 8 inches in loose thickness. Prior to compaction, each lift shall be watered or dried as needed to achieve near optimum moisture condition, mixed, and then compacted by mechanical methods, using sheepsfoot rollers, multiple-wheel pneumatic-tired rollers, or other appropriate compacting rollers, to the specified relative compaction. Successive lifts shall be treated in a like manner until the desired finished grades are achieved.

4.8. Fill shall be tested in the field by the geotechnical consultant for evaluation of general compliance with the recommended relative compaction and moisture conditions. Field density testing shall conform to ASTM D 1556-00 (Sand Cone method), D 2937-00 (Drive-Cylinder method), and/or D 2922-96 and D 3017-96 (Nuclear Gauge method). Generally, one test shall be provided for approximately every 2 vertical feet of fill placed, or for approximately every 1000 cubic yards of fill placed. In addition, on slope faces one or more tests shall be taken for approximately every 10,000 square feet of slope face and/or approximately every 10 vertical feet of slope height. Actual test intervals may vary as field conditions dictate. Fill found to be out of conformance with the grading recommendations shall be removed, moisture conditioned, and compacted or otherwise handled to accomplish general compliance with the grading recommendations.

4.9. The contractor shall assist the geotechnical consultant by excavating suitable borings for removal evaluation and/or for testing of compacted fill.

4.10. At the request of the geotechnical consultant, the contractor shall "shut down" or restrict grading equipment from operating in the area being tested to provide adequate testing time and safety for the field technician.

4.11. The geotechnical consultant shall maintain a map with the approximate locations of field density tests. Unless the client provides for surveying of the test locations, the locations shown by the geotechnical consultant will be estimated. The geotechnical consultant shall not be held responsible for the accuracy of the horizontal or vertical locations or elevations.

4.12. Grading operations shall be performed under the observation of the geotechnical consultant. Testing and evaluation by the geotechnical consultant does not preclude the need for approval by or other requirements of the jurisdictional agencies.

4.13. Fill materials shall not be placed, spread or compacted during unfavorable weather conditions. When work is interrupted by heavy rains, the filling operation shall not be resumed until tests indicate that moisture content and density of the fill meet the project specifications. Regrading of the near-surface soil may be needed to achieve the specified moisture content and density.

4.14. Upon completion of grading and termination of observation by the geotechnical consultant, no further filling or excavating, including that planned for footings, foundations, retaining walls or other features, shall be performed without the involvement of the geotechnical consultant.

4.15. Fill placed in areas not previously viewed and evaluated by the geotechnical consultant may have to be removed and recompacted at the contractor's expense. The depth and extent of removal of the unobserved and undocumented fill will be decided based upon review of the field conditions by the geotechnical consultant.

4.16. Off-site fill shall be treated in the same manner as recommended in these specifications for on-site fills. Off-site fill subdrains temporarily terminated (up gradient) shall be surveyed for future locating and connection.

## 5. OVERSIZED MATERIAL

Oversized material shall be placed in accordance with the following recommendations.

5.1. During the course of grading operations, rocks or similar irreducible materials greater than 6 inches in dimension (oversized material) may be generated. These materials shall not be placed within the compacted fill unless placed in general accordance with the recommendations of the geotechnical consultant.

5.2. Where oversized rock (greater than 6 inches in dimension) 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 designated for disposal areas shall be placed with sufficient sandy soil to generally fill voids. The disposal area shall be capped with a 5-foot thickness of fill which is generally free of oversized material.

5.3. Rocks 6 inches in dimension and smaller may be utilized within the compacted fill, provided they are placed in such a manner that nesting of rock is not permitted. Fill shall be placed and compacted over and around the rock. The amount of rock greater than ¾-inch in dimension shall generally not exceed 40 percent of the total dry weight of the fill mass, unless the fill is specially designed and constructed as a "rock fill."

5.4. Rocks or similar irreducible materials greater than 6 inches but less than 4 feet in dimension generated during grading may be placed in windrows and capped with finer materials in accordance with the recommendations of the geotechnical consultant and the approval of the governing agencies. Selected native or imported granular soil (Sand Equivalent of 30 or higher) shall be placed and flooded over and around the windrowed rock such that voids are filled. Windrows of oversized materials shall be staggered so that successive windrows of oversized materials are not in the same vertical plane. Rocks greater than 4 feet in dimension shall be broken down to 4 feet or smaller before placement, or they shall be disposed of off site.

## 6. SLOPES

The following sections provide recommendations for cut and fill slopes.

### 6.1. Cut Slopes

6.1.1. The geotechnical consultant shall observe cut slopes during excavation. The geotechnical consultant shall be notified by the contractor prior to beginning slope excavations.

6.1.2. If, during the course of grading, adverse or potentially adverse geotechnical conditions are encountered in the slope which were not anticipated in the preliminary evaluation report, the geotechnical consultant shall evaluate the conditions and provide appropriate recommendations.

### 6.2. Fill Slopes

6.2.1. When placing fill on slopes steeper than 5:1 (horizontal:vertical), topsoil, slope wash, colluvium, and other materials deemed unsuitable shall be removed. Near-horizontal keys and near-vertical benches shall be excavated into sound bedrock or fine fill material, in accordance with the recommendation of the geotechnical consultant. Keying and benching shall be accomplished. Compacted fill shall not be placed in an area subsequent to keying and benching until the area has been observed by the geotechnical consultant. Where the natural gradient of a slope is less than 5:1, benching is generally not recommended. However, fill shall not be placed on compressible or otherwise unsuitable materials left on the slope face.

6.2.2. 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 temporary slope, benching shall be conducted in the manner described in Section 6.2.1. A 3-foot or higher near-vertical bench shall be excavated into the documented fill prior to placement of additional fill.

6.2.3. Unless otherwise recommended by the geotechnical consultant and accepted by the Building Official, permanent fill slopes shall not be steeper than 2:1 (horizontal:vertical). The height of a fill slope shall be evaluated by the geotechnical consultant.

6.2.4. Unless specifically recommended otherwise, compacted fill slopes shall be overbuilt and cut back to grade, exposing firm compacted fill. The actual amount of overbuilding may vary as field conditions dictate. If the desired results are not achieved, the existing slopes shall be overexcavated and reconstructed in accordance with the recommendations of the geotechnical consultant. The degree of overbuilding may be increased until the desired compacted slope face condition is achieved. Care shall be taken by the contractor to provide mechanical compaction as close to the outer edge of the overbuilt slope surface as practical.

6.2.5. If access restrictions, property line location, or other constraints limit overbuilding and cutting back of the slope face, an alternative method for compaction of the slope face may be attempted by conventional construction procedures including backrolling at intervals of 4 feet or less in vertical slope height, or as dictated by the capability of the available equipment, whichever is less. Fill slopes shall be backrolled utilizing a conventional sheepsfoot-type roller. Care shall be taken to maintain the specified moisture conditions and/or reestablish the same, as needed, prior to backrolling.

6.2.6. The placement, moisture conditioning and compaction of fill slope materials shall be done in accordance with the recommendations presented in Section 5 of these guidelines.

6.2.7. The contractor shall be ultimately responsible for placing and compacting the soil out to the slope face to obtain a relative compaction of 90 percent as evaluated by ASTM D 1557 and a moisture content in accordance with Section 4. The geotechnical consultant shall perform field moisture and density tests at intervals of one test for approximately every 10,000 square feet of slope.

6.2.8. Backdrains shall be provided in fill as recommended by the geotechnical consultant.

6.3. Top-of-Slope Drainage

6.3.1. For pad areas above slopes, positive drainage shall be established away from the top of slope. This may be accomplished utilizing a berm and pad gradient of 2 percent or steeper at the top-of-slope areas. Site runoff shall not be permitted to flow over the tops of slopes.

6.3.2. Gunite-lined brow ditches shall be placed at the top of cut slopes to redirect surface runoff away from the slope face where drainage devices are not otherwise provided.

6.4. Slope Maintenance

6.4.1. In order to enhance surficial slope stability, slope planting shall be accomplished at the completion of grading. Slope plants shall consist of deep-rooting, variable root depth, drought-tolerant vegetation. Native vegetation is generally desirable. Plants native to semiarid and mid areas may also be appropriate. Large-leafed ice plant should not be used on slopes. A landscape architect shall be consulted regarding the actual types of plants and planting configuration to be used.

6.4.2. Irrigation pipes shall be anchored to slope faces and not placed in trenches excavated into slope faces. Slope irrigation shall be maintained at a level just sufficient to support plant growth. Property owners shall be made aware that over watering of slopes is detrimental to slope stability. Slopes shall be monitored regularly and broken sprinkler heads and/or pipes shall be repaired immediately.

6.4.3. Periodic observation of landscaped slope areas shall be planned and appropriate measures taken to enhance growth of landscape plants.

6.4.4. Graded swales at the top of slopes and terrace drains shall be installed and the property owners notified that the drains shall be periodically checked so that they may be kept clear. Damage to drainage improvements shall be repaired immediately. To reduce siltation, terrace drains shall be constructed at a gradient of 3 percent or steeper, in accordance with the recommendations of the project civil engineer.

6.4.5. If slope failures occur, the geotechnical consultant shall be contacted immediately for field review of site conditions and development of recommendations for evaluation and repair.

## 7. TRENCH BACKFILL

The following sections provide recommendations for backfilling of trenches.

7.1. Trench backfill shall consist of granular soils (bedding) extending from the trench bottom to 1 foot or more above the pipe. On-site or imported fill which has been evaluated by the geotechnical consultant may be used above the granular backfill. The cover soils directly in contact with the pipe shall be classified as having a very low expansion potential, in accordance with UBC Standard 18-2, and shall contain no rocks or chunks of hard soil larger than 3/4-inch in diameter.

7.2. Trench backfill shall, unless otherwise recommended, be compacted by mechanical means to 90 percent relative compaction as evaluated by ASTM D 1557. Backfill soils shall be placed in loose lifts 8-inches thick or thinner, moisture conditioned, and compacted in accordance with the recommendations of Section 4 of these guidelines. The backfill shall be tested by the geotechnical consultant at vertical intervals of approximately 2 feet of backfill placed and at spacings along the trench of approximately 100 feet in the same lift.

7.3. Jetting of trench backfill materials is generally not a recommended method of densification, unless the on-site soils are sufficiently free-draining and provisions have been made for adequate dissipation of the water utilized in the jetting process.

7.4. If it is decided that jetting may be utilized, granular material with a sand equivalent greater than 30 shall be used for backfilling in the areas to be jetted. Jetting shall generally be considered for trenches 2 feet or narrower in width and 4 feet or shallower in depth. Following jetting operations, trench backfill shall be mechanically compacted to the specified compaction to finish grade.

7.5. Trench backfill which underlies the zone of influence of foundations shall be mechanically compacted to 90 percent or greater relative compaction, as evaluated by ASTM D 1557-02. The zone of influence of the foundations is generally defined as the roughly triangular area within the limits of a 1:1 (horizontal:vertical) projection from the inner and outer edges of the foundation, projected down and out from both edges.

7.6. Trench backfill within slab areas shall be compacted by mechanical means to a relative compaction of 90 percent, as evaluated by ASTM D 1557. For minor interior trenches, density testing may be omitted or spot testing may be performed, as deemed appropriate by the geotechnical consultant.

7.7. When compacting soil in close proximity to utilities, care shall be taken by the grading contractor so that mechanical methods used to compact the soils do not damage the utilities. If the utility contractors indicate that it is undesirable to use compaction equipment in close proximity to a buried conduit, then the grading contractor may elect to use light mechanical compaction equipment or, with the approval of the geotechnical consultant, cover the conduit with clean granular material. These granular materials shall be jetted in place to the top of the conduit in accordance with the recommendations of Section 7.4 prior to initiating mechanical compaction procedures. Other methods of utility trench compaction may also be appropriate, upon review by the geotechnical consultant and the utility contractor, at the time of construction.

7.8. Clean granular backfill and/or bedding materials are not recommended for use in slope areas unless provisions are made for a drainage system to mitigate the potential for buildup of seepage forces or piping of backfill materials.

7.9. The contractor shall exercise the specified safety precautions, in accordance with OSHA Trench Safety Regulations, while conducting trenching operations. Such precautions include shoring or laying back trench excavations at 1:1 or flatter, depending on material type, for trenches in excess of 5 feet in depth. The geotechnical consultant is not responsible for the safety of trench operations or stability of the trenches.

## 8. DRAINAGE

The following sections provide recommendations pertaining to site drainage.

8.1. Roof, pad, and slope drainage shall be such that it is away from slopes and structures to suitable discharge areas by nonerodible devices (e.g., gutters, downspouts, concrete swales, etc.).

8.2. Positive drainage adjacent to structures shall be established and maintained. Positive drainage may be accomplished by providing drainage away from the foundations of the structure at a gradient of 2 percent or steeper for a distance of 5 feet or more outside the building perimeter, further maintained by a graded swale leading to an appropriate outlet, in accordance with the recommendations of the project civil engineer and/or landscape architect.

8.3. Surface drainage on the site shall be provided so that water is not permitted to pond. A gradient of 2 percent or steeper shall be maintained over the pad area and drainage patterns shall be established to remove water from the site to an appropriate outlet.

8.4. Care shall be taken by the contractor during grading to preserve any berms, drainage terraces, interceptor swales or other drainage devices of a permanent nature on or adjacent to the property. Drainage patterns established at the time of finish grading shall be maintained for the life of the project. Property owners shall be made very clearly aware that altering drainage patterns may be detrimental to slope stability and foundation performance.

## 9. SITE PROTECTION

The site shall be protected as outlined in the following sections.

9.1. Protection of the site during the period of grading shall 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 shall not be considered to preclude that portion or adjacent areas from the need for site protection, until such time as the project is finished as agreed upon by the geotechnical consultant, the client, and the regulatory agency.

9.2. The contractor is responsible for the stability of temporary excavations. Recommendations by the geotechnical consultant pertaining to temporary excavations are made in consideration of stability of the finished project and, therefore, shall not be considered to preclude the responsibilities of the contractor. Recommendations by the geotechnical consultant shall also not be considered to preclude more restrictive requirements by the applicable regulatory agencies.

9.3. Precautions shall be taken during the performance of site clearing, excavation, and grading to protect the site from flooding, ponding, or inundation by surface runoff. Temporary provisions shall be made during the rainy season so that surface runoff is away from and off the working site. Where low areas cannot be avoided, pumps shall be provided to remove water as needed during periods of rainfall.

9.4. During periods of rainfall, plastic sheeting shall be used as needed to reduce the potential for unprotected slopes to become saturated. Where needed, the contractor shall install check dams, desilting basins, riprap, sandbags or other appropriate devices or methods to reduce erosion and provide recommended conditions during inclement weather.

9.5. During periods of rainfall, the geotechnical consultant shall be kept informed by the contractor of the nature of remedial or precautionary work being performed on site (e.g., pumping, placement of sandbags or plastic sheeting, other labor, dozing, etc.).

9.6. Following periods of rainfall, the contractor shall 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 excavation and testing in order to aid in the evaluation. At the request of the geotechnical consultant, the contractor shall make excavations in order to aid in evaluation of the extent of rain-related damage.

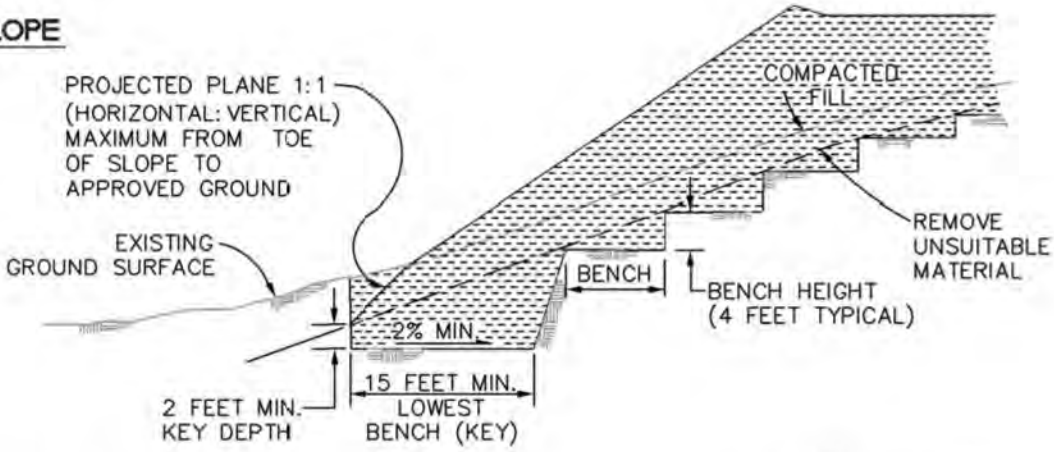
9.7. Rain or irrigation related damage shall be considered to include, but may not be limited to, erosion, silting, saturation, swelling, structural distress, and other adverse conditions noted by the geotechnical consultant. Soil adversely affected shall be classified as "Unsuitable Material" and shall be subject to overexcavation and replacement with compacted fill or to other remedial grading as recommended by the geotechnical consultant.

9.8. Relatively level areas where saturated soils and/or erosion gullies exist to depths greater than 1 foot shall be overexcavated to competent materials as evaluated by the geotechnical consultant. Where adverse conditions extend to less than 1 foot in depth, saturated and/or eroded materials may be processed in-place. Overexcavated or in-place processed materials shall be moisture conditioned and compacted in accordance with the recommendations provided in Section 4. If the desired results are not achieved, the affected materials shall be overexcavated, moisture conditioned, and compacted until the specifications are met.

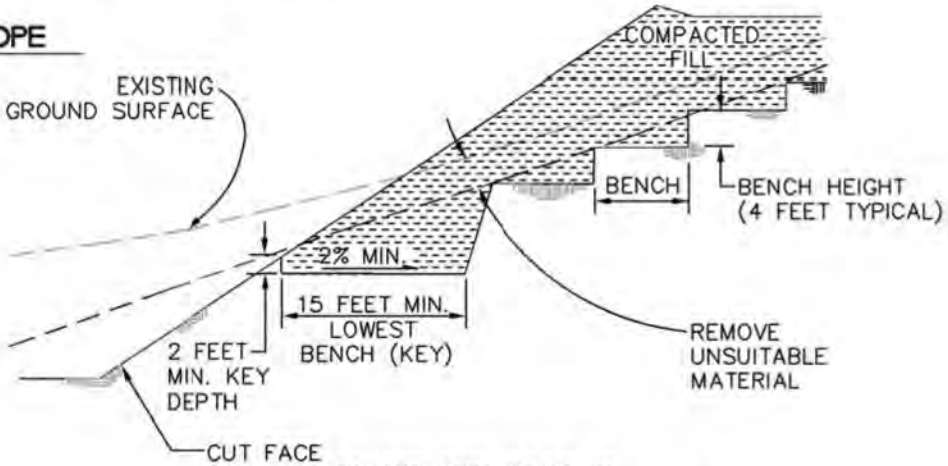
9.9. Slope areas where saturated soil and/or erosion gullies exist to depths greater than 1 foot shall be overexcavated and replaced as compacted fill in accordance with the applicable specifications. Where adversely affected materials exist to depths of I foot or less below proposed finished grade, remedial grading by moisture conditioning in-place and compaction in accordance with the appropriate specifications may be attempted. If the desired results are not achieved, the affected materials shall be overexcavated, moisture conditioned, and compacted until the specifications are met. As conditions dictate, other slope repair procedures may also be recommended by the geotechnical consultant.

9.10. During construction, the contractor shall grade the site to provide positive drainage away from structures and to keep water from ponding adjacent to structures. Water shall not be allowed to damage adjacent properties. Positive drainage shall be maintained by the contractor until permanent drainage and erosion reducing devices are installed in accordance with project plans.

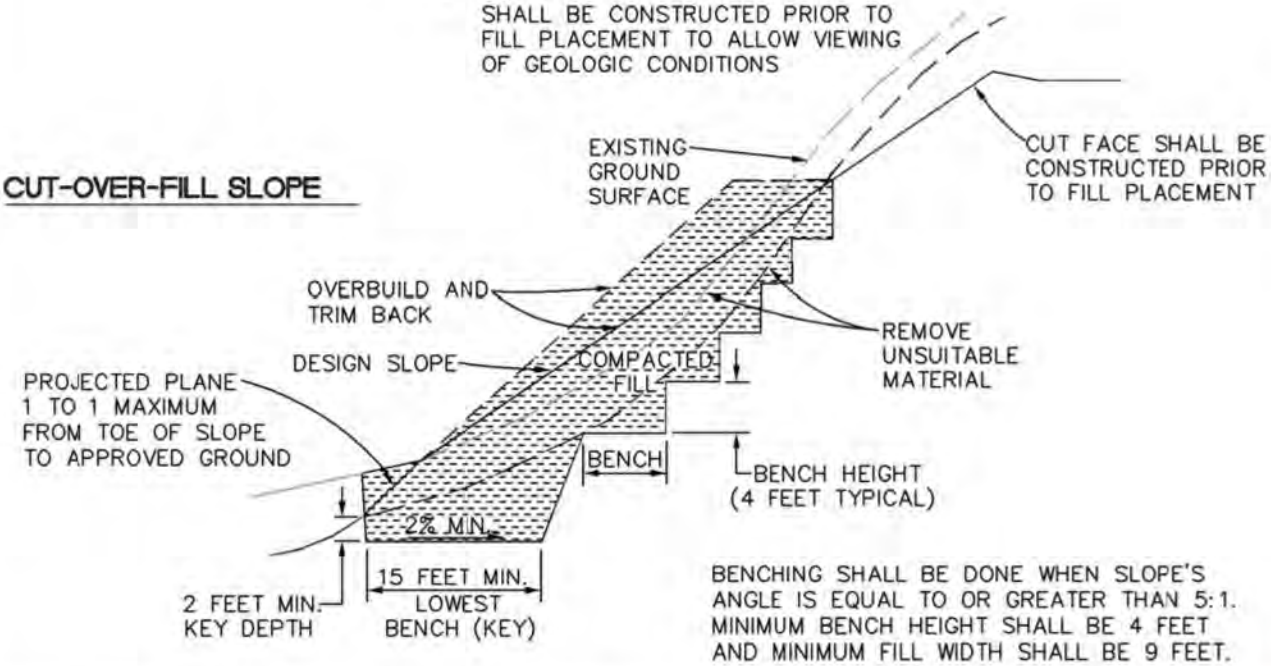
## FILL SLOPE




## FILL-OVER-CUT SLOPE




## CUT-OVER-FILL SLOPE

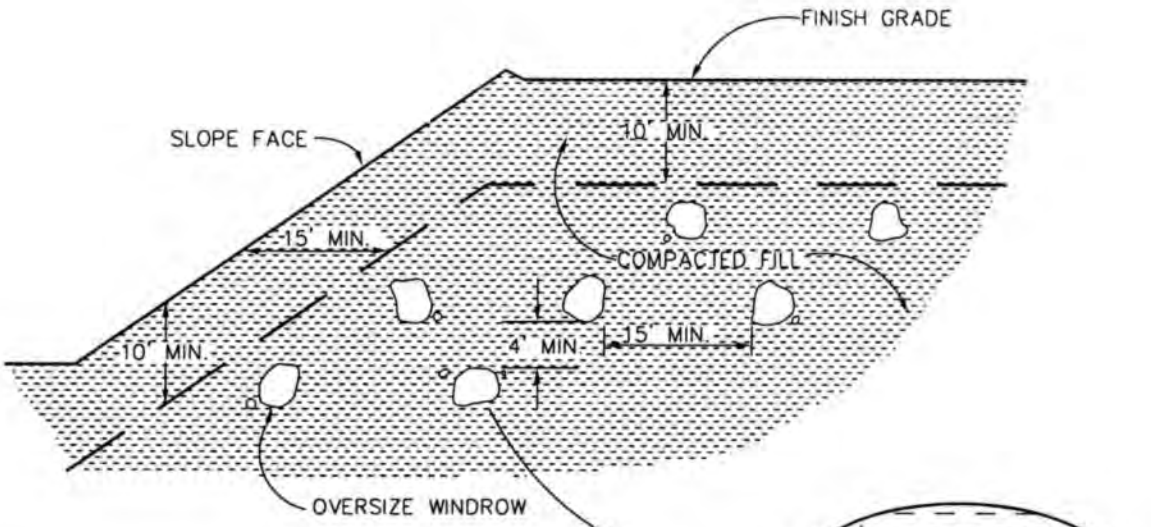


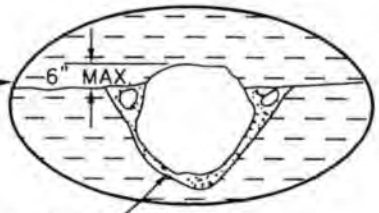

BENCHING SHALL BE DONE WHEN SLOPE'S ANGLE IS EQUAL TO OR GREATER THAN 5:1. MINIMUM BENCH HEIGHT SHALL BE 4 FEET AND MINIMUM FILL WIDTH SHALL BE 9 FEET.

# KEYING AND BENCHING

GENERAL EARTHWORK AND GRADING SPECIFICATIONS
STANDARD DETAIL A

NV5

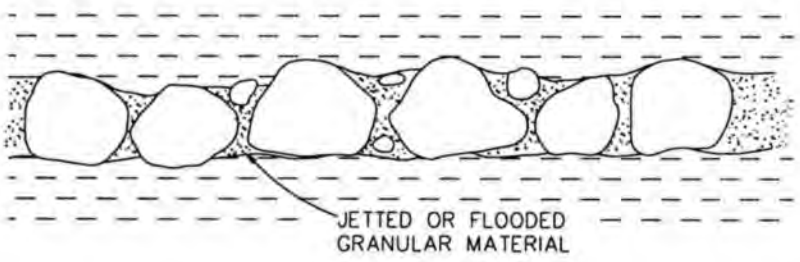



GRANULAR MATERIAL TO BE DENSIFIED IN PLACE BY FLOODING OR JETTING.

DETAIL

- OVERSIZE ROCK IS LARGER THAN 8 INCHES IN LARGEST DIMENSION.
- EXCAVATE A TRENCH IN THE COMPACTED FILL DEEP ENOUGH TO BURY ALL THE ROCK.
- BACKFILL WITH GRANULAR SOIL JETTED OR FLOODED IN PLACE TO FILL ALL THE VOIDS.
- DO NOT BURY ROCK WITHIN 10 FEET OF FINISH GRADE.
- WINDROW OF BURIED ROCK SHALL BE PARALLEL TO THE FINISHED SLOPE.

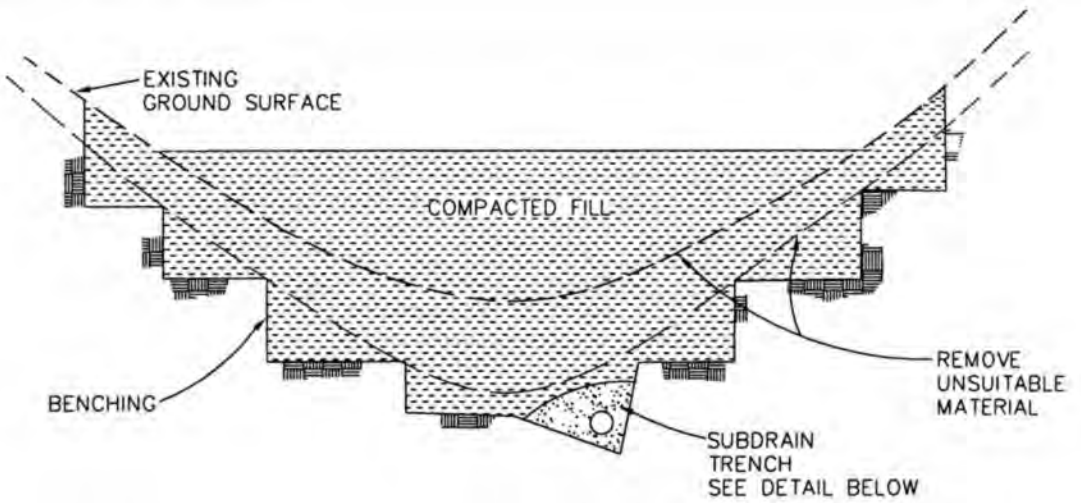


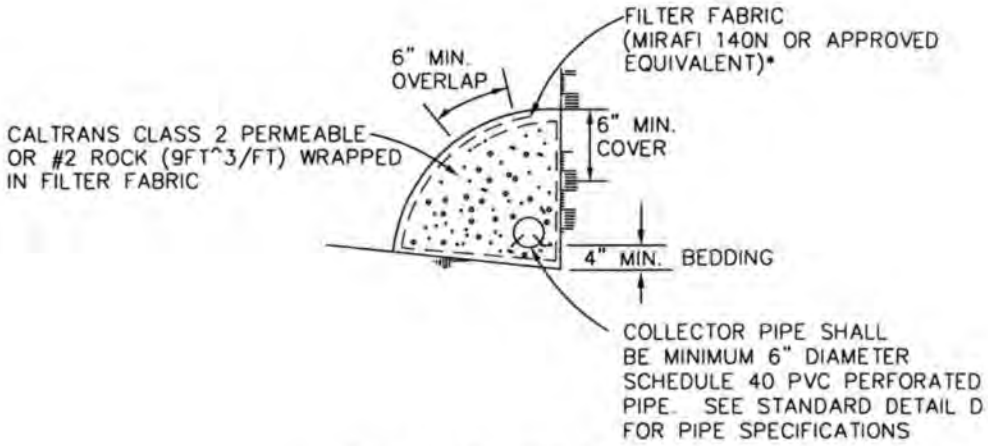

TYPICAL PROFILE ALONG WINDROW

# OVERSIZE ROCK DISPOSAL

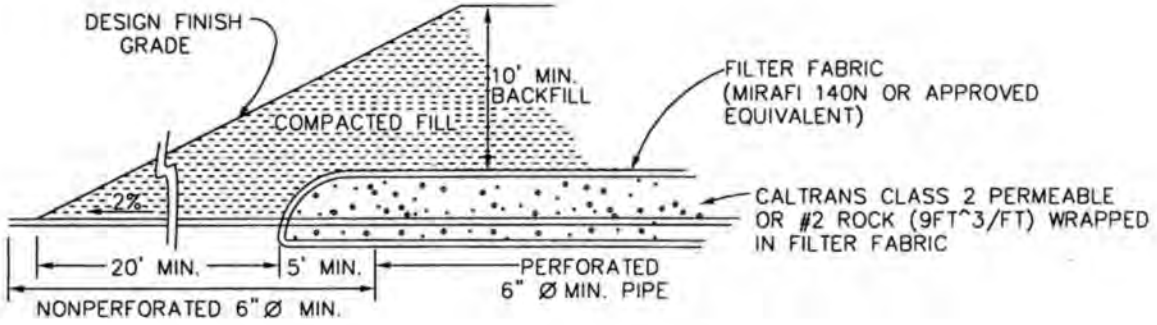
GENERAL EARTHWORK AND GRADING SPECIFICATIONS
STANDARD DETAIL B

N|V|5




**SUBDRAIN DETAIL**

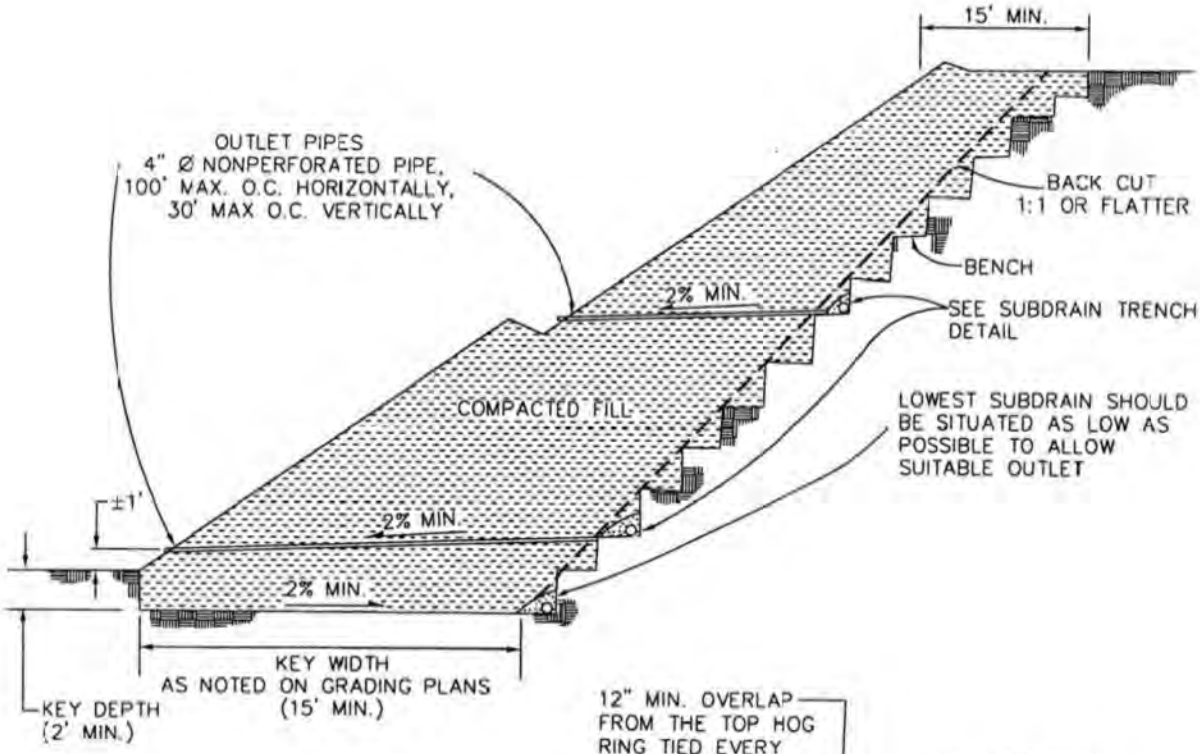


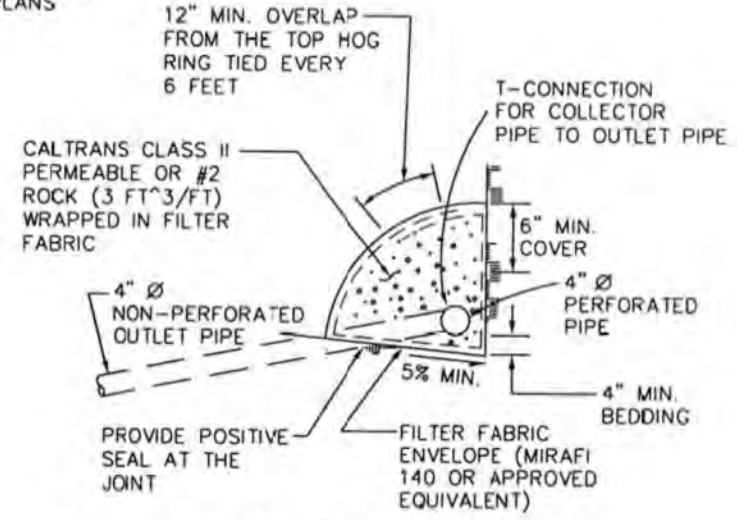

**DETAIL OF CANYON SUBDRAIN OUTLET**

# CANYON SUBDRAINS

GENERAL EARTHWORK AND
GRADING SPECIFICATIONS
STANDARD DETAIL C

NV5




**SUBDRAIN TRENCH DETAIL**

SUBDRAIN INSTALLATION – subdrain collector pipe shall be installed with perforation down or, unless otherwise designated by the geotechnical consultant. Outlet pipes shall be non-perforated pipe. The subdrain pipe shall have at least 8 perforations uniformly spaced per foot. Perforation shall be 1/4" to 1/2" if drill holes are used. All subdrain pipes shall have a gradient of at least 2% towards the outlet.

SUBDRAIN PIPE – Subdrain pipe shall be ASTM D2751, SDR 23.5 or ASTM D1527, Schedule 40, or ASTM D3034, SDR 23.5, Schedule 40 Polyvinyl Chloride Plastic (PVC) pipe.

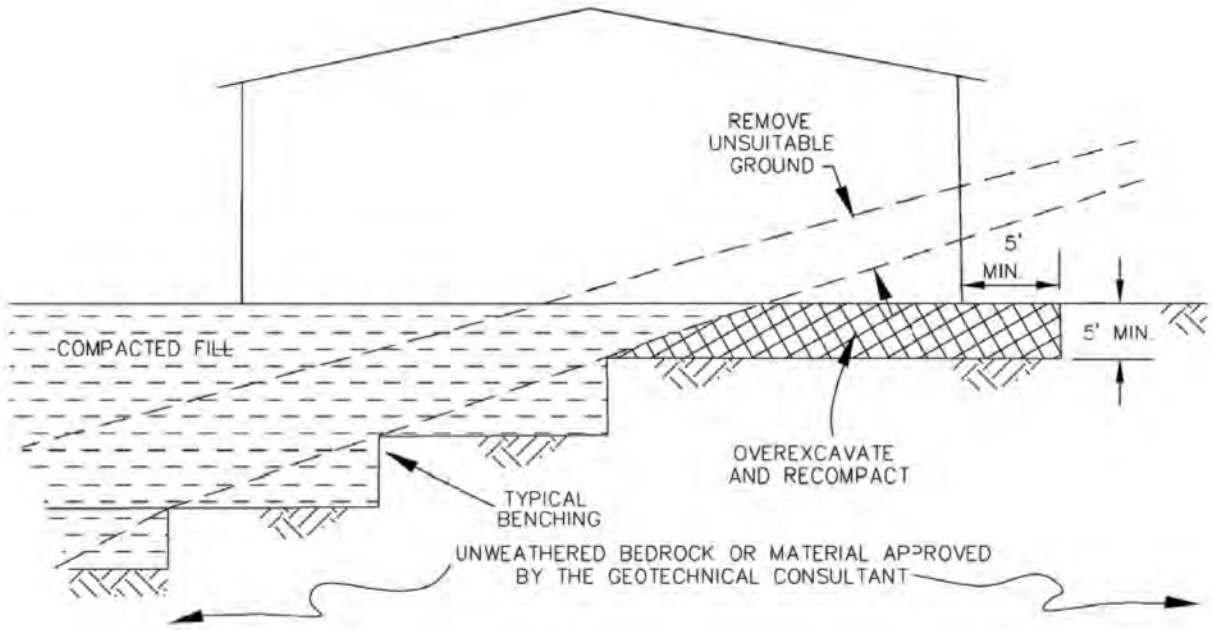
All outlet pipe shall be placed in a trench no wider than twice the subdrain pipe.

# BUTTRESS OR REPLACEMENT FILL SUBDRAINS

GENERAL EARTHWORK AND GRADING SPECIFICATIONS
STANDARD DETAIL D

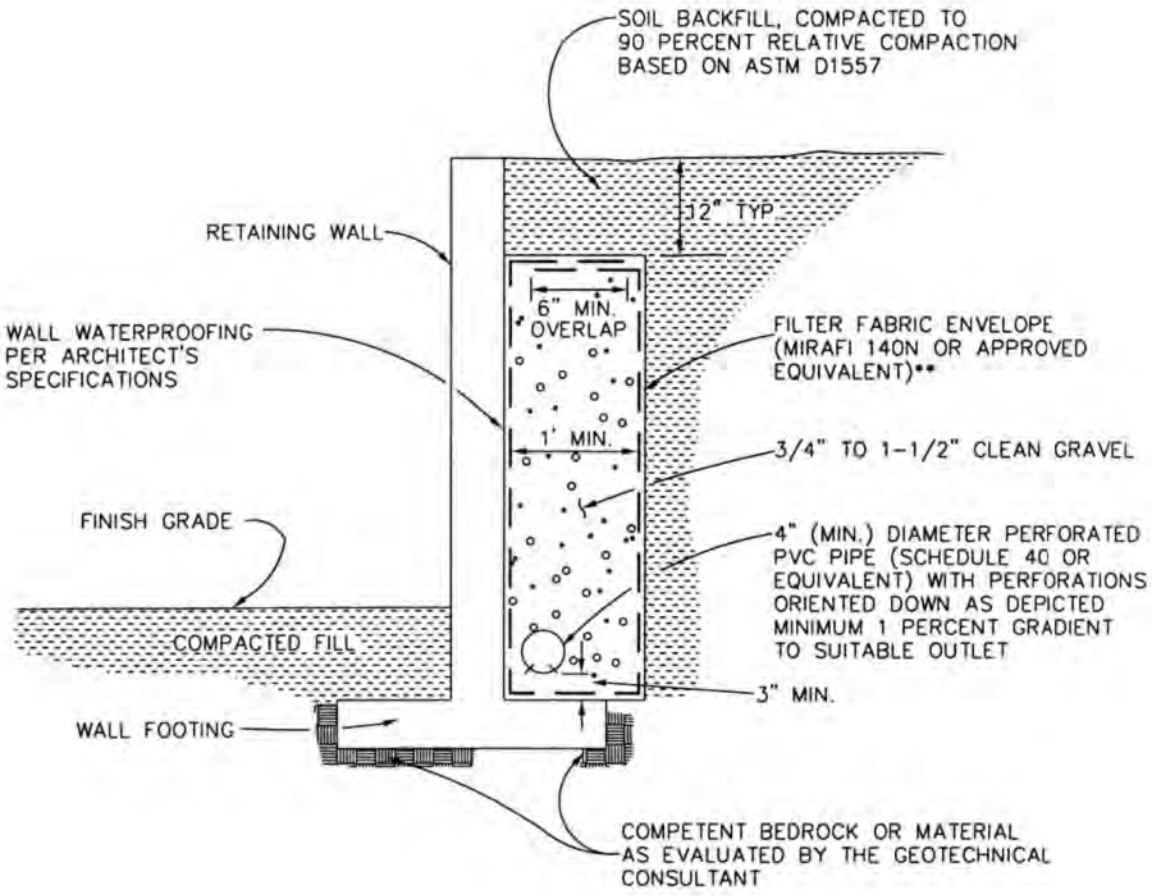
N|V|5

CUT–FILL TRANSITION LOT OVEREXCAVATION




# TRANSITION LOT FILLS

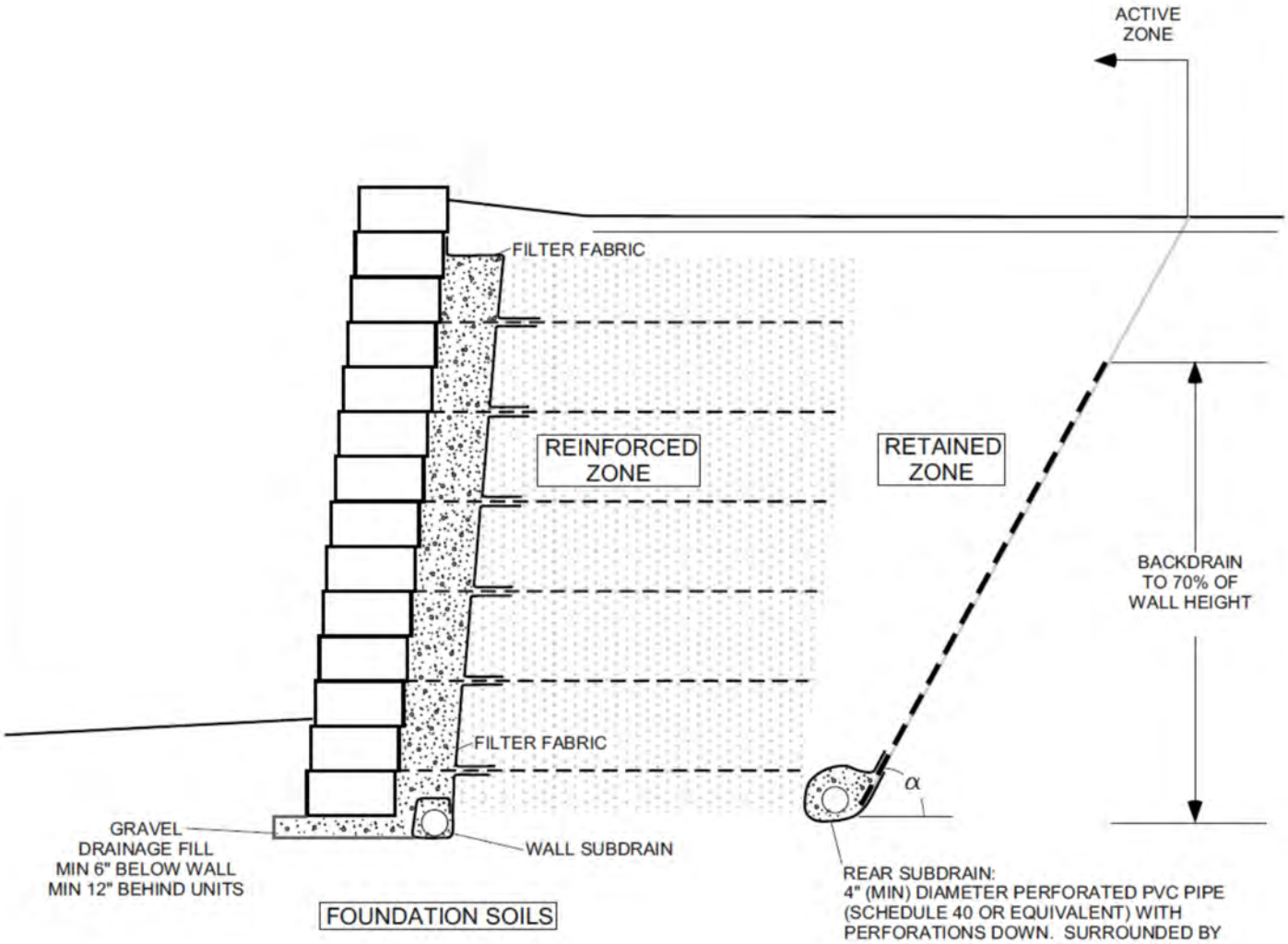
GENERAL EARTHWORK AND
GRADING SPECIFICATIONS
STANDARD DETAIL E




NOTE: UPON REVIEW BY THE GEOTECHNICAL CONSULTANT, COMPOSITE DRAINAGE PRODUCTS SUCH AS MIRADRAIN OR J-DRAIN MAY BE USED AS AN ALTERNATIVE TO GRAVEL OR CLASS 2 PERMEABLE MATERIAL. INSTALLATION SHOULD BE PERFORMED IN ACCORDANCE WITH MANUFACTURER'S SPECIFICATIONS.

# RETAINING WALL DRAINAGE

GENERAL EARTHWORK AND GRADING SPECIFICATIONS
STANDARD DETAIL F




NOTES:

1) MATERIAL GRADATION AND PLASTICITY

REINFORCED ZONE:

| SIEVE SIZE | % PASSING |
|---|---|
| 1 INCH | 100 |
| NO. 4 | 20-100 |
| NO. 40 | 0-60 |
| NO. 200 | 0-35 |

GRAVEL DRAINAGE FILL:

| SIEVE SIZE | % PASSING |
|---|---|
| 1 INCH | 100 |
| 3/4 INCH | 75-100 |
| NO. 4 | 0-60 |
| NO. 40 | 0-50 |
| NO. 200 | 0-5 |

FOR WALL HEIGHT < 10 FEET, PLASTICITY INDEX < 20
FOR WALL HEIGHT 10 TO 20 FEET, PLASTICITY INDEX < 10
FOR TIERED WALLS, USE COMBINED WALL HEIGHTS
WALL DESIGNER TO REQUEST SITE-SPECIFIC CRITERIA FOR WALL HEIGHT > 20 FEET

2) CONTRACTOR TO USE SOILS WITHIN THE RETAINED AND REINFORCED ZONES THAT MEET THE STRENGTH REQUIREMENTS OF WALL DESIGN.

3) GEOGRID REINFORCEMENT TO BE DESIGNED BY WALL DESIGNER CONSIDERING INTERNAL, EXTERNAL, AND COMPOUND STABILITY.

3) GEOGRID TO BE PRETENSIONED DURING INSTALLATION.

4) IMPROVEMENTS WITHIN THE ACTIVE ZONE ARE SUSCEPTIBLE TO POST-CONSTRUCTION SETTLEMENT. ANGLE $\alpha = 45+\Phi/2$, WHERE $\Phi$ IS THE FRICTION ANGLE OF THE MATERIAL IN THE RETAINED ZONE.

5) BACKDRAIN SHOULD CONSIST OF J-DRAIN 302 (OR EQUIVALENT) OR 6-INCH THICK DRAINAGE FILL WRAPPED IN FILTER FABRIC. PERCENT COVERAGE OF BACKDRAIN TO BE PER GEOTECHNICAL REVIEW.

# SEGMENTAL RETAINING WALLS

GENERAL EARTHWORK AND GRADING SPECIFICATIONS
STANDARD DETAIL G

NV5

Delivering Solutions
Improving Lives