APPENDIX D

Geotechnical Report

July 5, 2023

Project No. 23230

Belfield Developments, LLC
Attn: Mr. Sam Friedman
APN 063003105 & 063003106
Landers, CA

Subject: Preliminary Geotechnical Investigation Report
Proposed Hotel
APN 685-100-007 & 685-110-017
City of Landers, County of San Bernardino, California

Dear Mr. Friedman:

In accordance with your request and authorization, we are presenting the results of our geotechnical investigation for the proposed hotel to be constructed at APN 685-100-007 and 685-110-017, in the City of Landers, County of San Bernardino, California. The purpose of this investigation has been to evaluate the subsurface conditions at the site and to provide geotechnical engineering recommendations for the proposed construction.

Based on our findings, the proposed project is geotechnically feasible, provided that the recommendations in this report are incorporated into the design and are implemented during construction of the project. This report was prepared in accordance with the requirements of the 2022 California Building Code and the County of San Bernardino requirements.

We appreciate the opportunity to be of service on this project. Should you have any questions regarding this report or if we can be of further service, please do not hesitate to contact the undersigned at (657) 888-4608 or info@ntsgeo.com.

Respectfully submitted,
NTS GEOTECHNICAL, INC.

REGISTERED PROFESSIONAL ENGINEER
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NTS GEOTECHNICAL

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INTRODUCTION

This report presents the results of our geotechnical engineering evaluation performed for the proposed construction of tract homes located at APN 063003105 & 063003106 in the City of Landers, County of San Bernardino, California. See (Plate 1, Location Map). The purpose of this study has been to evaluate the subsurface conditions at the site and to provide geotechnical recommendations related to the design and construction of the proposed structures.

SITE AND PROJECT DESCRIPTION

The project site is located at APN 063003105 & 063003106, in the City of Landers, County of San Bernardino, California. The two lots are bound by vacant lots on the north, south, and east, and by Belfield Boulevard on the west. The nearly rectangular lots are currently vacant and occupied by native trees and bushes.

It is our understanding that the proposed project consists of construction of a one-story hotel, one-story restaurant and events building, and associated site work such as pavement, hardscape, pool, etc. Detailed plans such as civil and structural plans were not available during the preparation of this report, and thus this report is subject to change based on the final plans.

SCOPE OF WORK

As part of the preparation of this report, we have performed the following tasks:

Background Review

We reviewed readily available background data including in-house geologic maps, topographic maps, and aerial photographs relevant to the subject site in preparation of this report.

Field Exploration

The subsurface conditions were evaluated on June 23, 2023 by advancing five (5) borings to maximum depth of 15.5 feet below the existing grade. The approximate location of the boring is shown on Plate 2 – Geotechnical Map. Detailed exploration information of soils borings are presented in Appendix A, Field Exploration.

Geotechnical Laboratory Testing

Laboratory tests were performed on selected samples obtained from the boring in order to aid in the soil classification and to evaluate the engineering properties of the foundation soils. The following tests were performed in general accordance with ASTM standards:

- In-situ moisture and density;
- No. 200 wash;
- Sieve analysis;
- Direct Shear;
- Collapse; and
- Corrosivity.

Laboratory results are presented in Appendix B of this report.

SUBSURFACE CONDITIONS

Subsurface Materials

Earth materials encountered during our subsurface investigation consist of Quaternary alluvium. The mapped native materials are identified as Quaternary (Holocene), alluvial sand and gravel of valley areas. The alluvium consists of fine to coarse-grained sands and gravelly sands.

Alluvial materials were encountered during our surface investigation. In the alluvium consists of brown, dry, loose to medium dense, silty sands and sands.

Groundwater

Groundwater was not observed during our exploration to a maximum depth of 15.5 feet below the existing grade. Based on our review of nearby well data (Well No. 342678N1164075W001) we note that the highest groundwater was recorded at an elevation of 2939, which places groundwater at depth of over 110 feet below existing grade. Groundwater conditions may vary across the site due to stratigraphic and hydrologic conditions, and may change over time as a consequence of seasonal and meteorological fluctuations, or activities by humans at this site and nearby sites. However, based on the above findings, groundwater is unlikely to impact the proposed development.

GEOLOGIC HAZARDS

Faulting and Seismicity

The site is not located within an Alquist-Priolo Earthquake Fault Zone, and no known active faults are shown on the reviewed geologic maps crossing the site, however, the site is located in the seismically active region of Southern

California. The nearest known active fault is the Landers fault system, which is located approximately 2.1 miles from the subject site.

Liquefaction and Seismic Settlement

Liquefaction occurs when the pore pressures generated within a soil mass approach the effective overburden pressure. Liquefaction of soils may be caused by cyclic loading such as that imposed by ground shaking during earthquakes. The increase in pore pressure results in a loss of strength, and the soil then can undergo both horizontal and vertical movements, depending on the site conditions. Other phenomena associated with soil liquefaction include sand boils, ground oscillation, and loss of foundation bearing capacity. Liquefaction is generally known to occur in loose, saturated, relatively clean, fine-grained cohesionless soils at depths shallower than approximately 50 feet. Factors to consider in the evaluation of soil liquefaction potential include groundwater conditions, soil type, grain size distribution, relative density, degree of saturation, and both the intensity and duration of ground motion.

Based on our review of the County of San Bernardino Geologic Hazard Map, the site is not situated within an area identified to having a moderate susceptibility to liquefaction, however, based on the lack of shallow groundwater, it is our professional opinion that liquefaction potential is low.

Landslides

Based on our review of the referenced geologic maps, literature, topographic maps, aerial photographs, and our subsurface evaluation, no landslides or related features underlie or are adjacent to the subject site. Due to the relatively level nature of the site and surrounding areas, the potential for landslides at the project site is considered low.

Flooding

The Federal Emergency Management Agency (FEMA) has prepared flood insurance rate maps (FIRMs) for use in administering the National Flood Insurance Program. Based on our review of the FEMA flood map, the site is located in an Area of Undetermined Flood Hazard (Zone D). The potential for flooding to impact the proposed improvement should be evaluated by the project designer.

Tsunami and Seiches

Tsunamis are waves generated by massive landslides near or under sea water. The site is not located on any State of California Tsunami Inundation Map for Emergency Planning. The potential for the site to be adversely impacted by earthquake-induced tsunamis is considered to be negligible because the site is located several miles inland from the Pacific Ocean shore, at an elevation exceeding the maximum height of potential tsunami inundation.

Seiches are standing wave oscillations of an enclosed water body after the original driving force has dissipated. The potential for the site to be adversely impacted by earthquake-induced seiches is considered to be negligible due to the lack of any significant enclosed bodies of water located in the vicinity of the site.

GEOTECHNICAL ENGINEERING FINDINGS

Expansive Soil

Based on our evaluation, laboratory testing and experience with similar material types, the soils encountered near the ground surface at the site exhibit a very low expansion potential.

Hydroconsolidation

Based on our laboratory test results, and the loose nature of the upper approximately 5 feet of the site soils, the potential for hydrocollapse settlement to affect the proposed structures should be considered low to moderate. Grading recommendations to minimize hydroconsolidation are provided in this report.

Soil Corrosion

The potential for the on-site materials to corrode buried steel and concrete improvements was evaluated. Laboratory testing was performed on representative soil samples to evaluate pH, minimum resistivity, and soluble chloride and sulfate contents. The results of our corrosivity testing is presented within Appendix B of this report. General recommendations to address the corrosion potential of the on-site soils are provided below. Imported fill materials, if used, should be tested to evaluate whether their corrosion potential is more severe than those assumed.

Structural Concrete

Laboratory tests indicate that the potential of sulfate attack on concrete in contact with the on-site soils is “negligible” or “S0” exposure in accordance with ACI 318, Table 19.3.1.1. Therefore, restriction on the type of cement, water to cement ratio, and compressive strength is not required.

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

Ferrous Metal

The results of the laboratory chemical tests performed on a sample of soil collected within the site indicate that the on-site soils are mildy corrosive to ferrous metals. Consequently, metal structures which will be in direct contact with the soil (i.e., underground metal conduits, pipelines, metal sign posts, etc.) and/or in close proximity to the soil (wrought iron fencing, etc.) may be subject to corrosion. The use of special coatings or cathodic protection around buried metal structures has been shown to be beneficial in reducing corrosion potential.

Laboratory tests reveal a low chloride level, which indicates that the onsite soil is considered non-corrosive toward reinforcing steel. The laboratory testing program performed for this project does not address the potential for corrosion to copper piping. In this regard, a corrosion engineer should be consulted to perform more detailed testing and develop appropriate mitigation measures (if necessary).

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

Excavation Characteristics

The majority of the soil materials underlying the site can be excavated with excavators and other conventional grading equipment.

Shrinkage

The shrinkage factor for earthwork is expected to range from about 10 to 15 percent for the site soils. This estimate is based on a compactive effort to achieve an average relative compaction of 90 percent and may vary with contractor means and methods and actual comp active efforts. Subsidence is estimated to be approximately 0.20 feet. Losses from site clearing and removal of existing site improvements may affect earthwork quantity and should be considered.

GEOTECHNICAL ENGINEERING CONLUSIONS AND RECOMMENDATIONS

Conclusions

Based on the results of our field exploration and engineering analyses, it is our opinion that the proposed development is feasible from a geotechnical standpoint, provided that the recommendations in this report are incorporated into the design plans and are implemented during construction.

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

- The proposed structure may be supported on a shallow spread/continuous footing foundation system underlain by engineered fill.
- Groundwater is not anticipated to directly impact the planned precise grading or during the installation of shallow underground utilities.
- The site is not located within a fault zone, however, the site will experience strong ground shaking due to it's proximity to the San Andreas fault.
- Based on the lack of shallow groundwater and relatively dense nature of the subsurface soil, the liquefaction potential is considered low.
- The magnitude of total static settlements beneath the structure is expected to be less than 1.0 inch, with differential settlement on the order of ½ -inch over a span of 30 feet.
- The on-site soils has a negligible sulfate exposure to concrete (i.e., as defined by the CBC) and reinforcement.

Our geotechnical engineering analyses performed for this report were based on the earth materials encountered during the subsurface exploration for the site. If the design substantially changes, then our geotechnical engineering recommendations would be subject to revision based on our evaluation of the changes. The following sections present our conclusions and recommendations pertaining to the engineering design for this project.

Site Preparation

Site preparation should begin with the removal of utility lines, asphalt, concrete, vegetation, and other deleterious debris from areas to be graded. Tree stumps and roots should be removed to such a depth that organic material is generally not present. Clearing and grubbing should extend to the outside edges of the proposed excavation and fill areas. We recommend that unsuitable materials such as organic matter or oversized material be selectively removed and disposed offsite. The debris and unsuitable material generated during clearing and grubbing should be removed from areas to be graded and disposed at a legal dump site away from the project area.

Remedial Grading

Due to the dry / loose nature of the near surface soils, we recommend that the upper 5 feet of the site soils be removed and recompacted to achieve a uniform blanket of properly moisture conditioned and compacted fill material prior to placement of new fill or new foundation.

It should be noted that the recommendations provided herein are based on our subsurface exploration and knowledge of the on-site geology. Actual removals may vary in configuration and volume based on observations of geologic materials and conditions encountered during grading. The bottom of all corrective grading removals should be observed by a representative of NTS to verify the suitability of in-place soil prior to performing scarification and recompaction. Remedial grading recommendations are outlined below.

Fill Areas:

Areas to receive structural fill should be prepared by removing organic growth from the pad surface and other existing improvements. These areas should then be moisture conditioned to at least 2 percent above optimum to a depth of 5 feet below the existing grade, and should be compacted to achieve 90 percent relative compaction. A representative of NTS should be onsite to determine the actual depth of removal and perform compaction testing to verify the required moisture compaction is achieved in the field. Fill placed above the existing grade should be placed in accordance with the Compacted Fill section of this report.

Cut Areas:

Areas that are planned to be cut should be thoroughly watered after the proposed cuts are made to obtain a moisture content that is 2 percent above optimum moisture content to a depth of 3 feet below the finish grade. The moisture conditioned soil should be compacted to at least 90 percent relative compaction. Wherever a building pad spans a cut/fill transition, then the building pad area should be overexcavated to a depth of 3 feet below the footing and recompacted to achieve a uniform blanket of compacted fill.

Building Pads

In order to create a firm and stable platform on which to construct the new building pads, we recommend the following:

- The proposed building pads should be excavated to a depth of at least 3 feet from finish rough grade.
- The bottom of the over excavation should then be scarified to a depth of at least 8 inches, thoroughly flooded to raise the moisture content of the underlying soils to at least 2 percent above optimum moisture content, and should be recompacted using heavy vibratory compaction equipment prior to placement of any fill.
- Following the approval of the over-excavation bottom by a representative of NTS, the onsite material may be used as fill material to achieve the planned pad grade.
- The fill material should then be placed in 6- to- 8-inch-thick lifts, moisture conditioned to near optimum moisture content and compacted to achieve 90 percent relative compaction.

Streets Improvement

In order to create a firm and stable platform on which to construct the new vehicular pavement, we recommend the following:

- The proposed pavement should be excavated to the planned subgrade (i.e., bottom of aggregate base for pavement).
- The bottom of the excavation should then be scarified to a depth of 12 inches below the planned subgrade.
- The bottom of the over excavation should then be scarified to a depth of at least 6 inches, moisture conditioned to 2 percent above optimum moisture content and recompacted to at least 90 percent relative compaction as determined in accordance with ASTM D1557.
- Following the approval of the over-excavation bottom by a representative of NTS, the onsite material may be used as fill material to achieve the planned pad grade.
- The fill material should then be placed in 6- to- 8-inch-thick lifts, moisture conditioned to near optimum moisture content and compacted to achieve 90 percent relative compaction.

If the existing loose fill materials are found to be disturbed to depths greater than the proposed remedial grading, then the depth of over-excavation and re-compaction should be increased accordingly in local areas as recommended by a representative of NTS.

The zones of compaction should extend at least 5 feet outside the perimeter of the building pads, and may change based on actual side conditions during grading and proposed elevations of the final approved grading plan.

Materials for Fill

On-site soils with an organic content of less than 3 percent by volume (or 1 percent by weight) are suitable for use as fill. Soil material to be used as fill should not contain contaminated materials, rocks, or lumps over 6 inches in largest dimension, and not more than 40 percent larger than ¾ inch. Utility trench backfill material should not contain rocks or lumps over 3 inches in largest dimension. Larger chunks, if generated during excavation, may be broken into acceptably sized pieces or may be disposed offsite.

Any imported fill material should consist of granular soil having a “very low” expansion potential (that is, expansion index of 20 or less). Import material should also have low corrosion potential (that is, chloride content less than 500 parts per million [ppm], soluble sulfate content of less than 0.1 percent, and pH of 5.5 or higher). Materials to be used as fill should be evaluated by a representative of NTS prior to importing or filling.

Compacted Fill

Prior to placement of compacted fill, the contractor should request an evaluation of the exposed excavation bottom by NTS. Unless otherwise recommended, the exposed ground surface should then be scarified to a depth of at least 6 inches and watered or dried, as needed, to achieve generally consistent moisture contents approximately 2 percent above the optimum moisture content. The scarified materials should then be compacted to 90 percent relative compaction in accordance with the latest version of ASTM Test Method D1557.

Compacted fill should be placed in horizontal lifts of approximately 6 to 8 inches in loose thickness. Prior to compaction, each lift should be watered or dried as needed to achieve near optimum moisture condition, mixed, and then compacted to a relative compaction of 90 percent as evaluated by ASTM D1557. Successive lifts should be treated in a like manner until the desired finished grades are achieved.

Personnel from NTS should observe the excavations so that any necessary modifications based on variations in the encountered soil conditions can be made. All applicable safety requirements and regulations, including CalOSHA requirements, should be met.

Temporary Excavations

Temporary excavations for the demolishing, earthwork, footing and utility trench are expected. We anticipate that unsurcharged excavations with vertical side slopes less than 3 feet high will generally be stable; however, sloughing of cohesionless sandy materials encountered at the site should be expected.

Where the space is available, temporary, unsurcharged excavation sides over 3 feet in height should be sloped no steeper than an inclination of 1.5H:1V (horizontal:vertical).Where sloped excavations are created, the tops of the slopes should be barricaded so that vehicles and storage loads do not encroach within 10 feet of the top of the excavated slopes. A greater setback may be necessary when considering heavy vehicles, such as concrete trucks and cranes. NTS should be advised of such heavy vehicle loadings so that specific setback requirements can be established. If the temporary construction slopes are to be maintained during the rainy season, berms are recommended to be graded along the tops of the slopes in order to prevent runoff water from entering the excavation and eroding the slope faces. Where space for sloped excavations is not available, temporary shoring may be utilized.

Personnel from NTS should observe the excavation so that any necessary modifications based on variations in the encountered soil conditions can be made. All applicable safety requirements and regulations, including CalOSHA requirements, should be met.

Seismic Design

Based on our subsurface investigation, the site is designated as Site Class D (“stiff soil” soil profile). The seismic design parameters based on ASCE 7-16 and 2022 CBC are listed in the following table.

2022 CBC and ASCE 7-16 Seismic Design Parameters
(To be utilized as per the requirements of Section 11.4.8 of ASCE 7-16)

Seismic Item	Design Value	2016 ASCE 7-16 or 2019 CBC Reference
Site Class based on soil profile (ASCE 7-16 Table 20.3-1)	D[a]	ASCE 7-16 Table 20.3-1
Short Period Spectral Acceleration S_s	1.941[a]	CBC Figures 1613.2.1 (1-8)
1-sec. Period Spectral Acceleration S_1	0.653[a]	CBC Figures 1613.2.1 (1-8)
Site Coefficient F_a (2019 CBC Table 1613.2.3(1))	1.000[a]	CBC Table 1613.2.3 (1)
Site Coefficient F_v (2019 CBC Table 1613.2.3(2))	1.700[b]	CBC Table 1613.2.3 (2)
Short Period MCE* Spectral Acceleration S_{MS} $S_{MS} = F_a S_s$	1.941[a]	CBC Equation 16-36
1-sec. Period MCE Spectral Acceleration S_{M1} $S_{M1} = F_v S_1$	1.110[b]	CBC Equation 16-37
Short Period Design Spectral Acceleration S_{DS} $S_{DS} = 2/3S_{Ms}$	1.294[a]	CBC Equation 16-38
1-sec. Period Design Spectral Acceleration S_{D1} $S_{D1} = 2/3S_{M1}$	0.740[b]	CBC Equation 16-39
Short Period Transition Period T_S (sec) $T_S = S_{D1}/S_{DS}$	0.572[b]	ASCE 7-16 Section 11.4.6
Long Period Transition Period Tl (sec)	8[b]	ASCE 7-16 Figures 22-14 to 22-17
MCE[c] Peak Ground Acceleration (PGA)	0.821[a]	ASCE 7-16 Figures 22-9 to 22-13
Site Coefficient F_{PGA} (ASCE 7-16 Table 11.8-1)	1.100[a]	ASCE 7-16 Table 11.8-1
Modified MCE[c] Peak Ground Acceleration (PGA_M)	0.903[a]	ASCE 7-16 Equation 11.8-1

(a) Design Values Obtained from USGS Earthquake Hazards Program website that are based on the ASCE-7-16 and 2022 CBC and site coordinates of N34.269322° and W116.403991°.
(b) Design Values Determined per ASCE Table 11.4-2 and CBC Equations 16-36 through 16-39.
(c) MCE: Maximum Considered Earthquake.

Since the Site Class is designated as D and the S_1 value is greater than or equal to 0.2, the 2022 CBC requires either a site-specific seismic hazard analysis per Section 21.2 of ASCE 7-16 or the application of Exception 2 of Section 11.4.8 of ASCE 7-16. The project structural engineer should apply all requirements of Section 11.4.8 of ASCE 7-16 to determine if increases to the seismic response coefficient (i.e. increases to the loading of the structure) are required.

It should be recognized that much of southern California is subject to some level of damaging ground shaking as a result of movement along the major active (and potentially active) fault zones that characterize this region. Design utilizing the 2022 CBC is not meant to completely protect against damage or loss of function. Therefore, the preceding parameters should be considered as minimum design criteria.

Foundation Design and Construction

A shallow foundation system may be used for support of the proposed buildings, provided that all the footings are placed on engineered fill prepared as described in the "**Remedial Grading**" section of this report. Our geotechnical foundation design parameters are presented in the table below:

Foundation Design Parameters

Bearing Material	▪ Engineered Fill
Minimum Footing Size	▪ Width: 12 inches ▪ Depth: 18 inches below the lowest adjacent soil grade
Minimum Footing Reinforcement	▪ Footings reinforcement should consist of at least four No. 4 bars (two on top and two on bottom). ▪ Final reinforcement should be determined by the project structural engineer.
Allowable Bearing Capacity	▪ 2,000 psf for the minimum footing size given above. ▪ The above value may be increased by 1/3 for temporary loads such as wind or earthquake.
Static Settlement	▪ Total static settlement of 1 inch with differential settlement estimated to be approximately ½ inch over a span of 40 feet
Allowable Lateral Passive Resistance	• 300 pcf (equivalent fluid pressure)
Allowable Coefficient of Friction	• 0.35

Slab-On-Grade Design and Construction

The slab-on-grade should be designed and constructed with the minimum recommendations presented below, however, final design of the slab should be determined by the project structural engineer.

<u>Slab Thickness</u>: Slack thickness and final reinforcement of the slab-on-grade are contingent on the recommendations of the structural engineer or architect. Based on our findings, a modulus of subgrade reaction of approximately 100 pci may be used in concrete slab design for the expected very low expansion subgrade. The slab should be designed to sufficiently support both dead and live loads and account for variation in soil conditions at the completion of rough grading.

Minimum Slab Reinforcement: Minimum slab reinforcement shall not be less than No. 4 bars placed at 16 inches on center. Welded wire mesh is not recommended. Care should be taken to position the reinforcement bars in the center of the slab.

Slab Subgrade:

- The upper 24 inches of the on-site soil encountered at the slab subgrade should be moisture conditioned to near optimum moisture content and compacted to a minimum relative compaction of compacted to 90 percent relative compaction in accordance with the latest version of ASTM D1557.

- A moisture vapor retarder should be placed in accordance with the "Moisture Vapor Retarder" section below.

Pole Foundations

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

Bearing Materials: The pole foundations may bear into competent native soils approved by a representative from NTS.

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

Lateral Load Design: Lateral loads may be resisted by passive resistance within the adjacent earth materials. For passive resistance, an allowable passive earth pressure of 300 pounds per foot of pile diameter per foot of depth into competent bearing material may be used; however, passive resistance should be disregarded within the upper foot due to possible disturbance during drilling. The passive resistance value may be applied over an area equivalent to two pile diameters.

Moisture Vapor Retarder

A vapor retarder, such as a 15-mil-thick moisture vapor retarder that meets the requirements of ASTM E1745 Class C (Stego Wrap or equivalent) should be placed directly over the prepared soil subgrade to provide protection against vapor transmission through concrete floor slabs thatare anticipated to receive carpet, tile or other moisture sensitive coverings. The use of moisture vapor retarder should be determined by the project architect. At minimum, the vapor retarder should be installed as follows:

- Per the manufacture's specifications as well as with the applicable recognized installation procedures such as ASTM E1643;
- Joints between the sheets and the openings for utility piping should be lapped and taped. If the barrier is not continuously placed across footings/ribs, the barrier should at minimum be lapped into the side of the footing/rib trenches down to the bottom of the trench; and,
- Punctures in the vapor retarder should be repaired prior to concrete placement.

It should be noted that the moisture retarder is intended only to reduce moisture vapor transmissions from the soil beneath the concrete and is consistent with the current standard of the industry in the building construction in Southern California. It is not intended to provide a "waterproof" or "vapor proof" barrier or reduce vapor transmission from sources above the retarder (i.e., concrete). The evaluation of water vapor from any source and its effect on any aspect of the proposed building space above the slab (i.e., floor covering applicability, mold growth, etc.) is beyond our purview and the scope of this report.

Pool Design Criteria

The proposed shell for the swimming pool should be designed for a ***very low expansive*** soil conditions and be in minimum accordance with and Plate 3 – Pool and Spa Design Criteria for low to medium expansive soil sites. Very low expansive soils, which are mildly corrosive to ferrous metals, and contain a negligible level of sulfate conditions should be considered in the design.

<u>Pool Bottom</u>

It is expected that the pool bottom will rest entirely on competent engineered fill as discussed in the ***Remedial Grading*** section of this report. The bottom should be observed by a representative of NTS prior to placement of rebar and concrete.

<u>Plumbing</u>

Leakage from the spa or from any of the appurtenant plumbing could create adverse saturated conditions of the surrounding subgrade soils. Localized areas of over-saturation can lead to differential settlement or collapse of the subgrade soils and subsequent raising and shifting of concrete flatwork. Therefore, it is essential that all plumbing fixtures be absolutely leak-free. For similar reasons, drainage from deck areas should be directed to local area drains and/or graded earth swales designed to carry runoff water to the adjacent street.

Future irrigation could result in the development of perched water zones which could affect subsurface improvements. Heavy-duty pipes and flexible couplings should be used for the pool plumbing system to minimize leaking which may produce additional pressures on the pool shell. In addition, installation of a pressure valve in the pool bottom should be used to mitigate any potential buildup of pressure.

Utility Trench Backfill Considerations

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

<u>Pipe Zone (Bedding and Shading)</u>

The pipe bedding and shading materials should extend from at least 6 inches below the pipes to at least 12 inches above the crown of the pipes. Pipe bedding and shading should consist of either clean sand with a sand equivalent (SE) of at least 30, or crushed rock. If crushed rock is used, it should consist of ¾-inch crushed rock that conforms to Table 200-1.2.1 (A) of the 2022 “Greenbook.” Pipe bedding and shading should also meet the minimum requirements of the City of Los Angeles. If the requirements of the City are more stringent, they should take precedence over the geotechnical recommendations. Sufficient laboratory testing should be performed to verify the bedding and shading meets the minimum requirements of the Greenbook and County of San Bernardino grading codes.

Granular pipe bedding and shading material should be properly placed in thicknesses not exceeding 3 feet, and then sufficiently flooded or jetted in place. Crushed rock, if used, should be capped with filter fabric (Mirafi 160N, or equivalent; Mirafi 140N filter fabric is suitable if available) to prevent the migration of fines into the rock.

<u>Trench Backfill</u>

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

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

Soils to be used as trench backfill should be moistened, dried, or blended as necessary to achieve near optimum moisture content, placed in lifts which, prior to compaction shall not exceed the thickness specified in Section 306-12.3 of the 2018 "Greenbook" for various types of equipment, and mechanically compacted/densified to at least 90 percent relative compaction as determined by ASTM Test Method D 1557. Jetting is not permitted in this trench zone.

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

Asphalt Concrete Pavement Design

In accordance with Chapter 600 of the Caltrans Highway Design Manual, we have performed pavement structural design utilizing assumed traffic indices (TI) of 5.5 and 6.0 and assumed R-value of 30. Based on our analysis, we have developed the pavement structural sections presented in the following table. We note that the assumed TI's should be reviewed by a traffic engineer to confirm their applicability to the project. Additionally, the R-value testing should be performed at the completion of rough grading of the roadways to confirm the pavement thickness provided herein.

Asphalt Concrete Pavement Structural Sections

Location	Traffic Index	Asphalt Concrete (in.)	Aggregate Base (in.)*
Driveways	5.5	4.0	5.0
Private Streets	6.0	4.0	6.0

The planned pavement structural sections should consist of the following:

- Aggregate Base materials (AB) consisted of either Crushed Aggregate Base (CAB) or Crushed Miscellaneous Base (CMB).
- Asphalt Concrete (AC) material of a type meeting the minimum City of Rancho Mirage standards.
- The subgrade soils should be moisture conditioned to near optimum moisture content to a depth of at least 18 inches and compacted to 90 percent relative compaction.

- The AB and AC should be compacted to at least 95 percent relative compaction.

Exterior Flatwork/Hardscape Design Considerations

For exterior flatwork and hardscape planned as part of the proposed development, the following design may be considered by the project civil engineer. These recommendations may be considered as minimal design based on the soils conditions encountered during our investigation. Final design of the proposed flatwork and hardscape area should be provided by the project civil engineer. Based on the conditions encountered, we recommend that the subgrade for the subject concrete flatwork and hardscape be moisture conditioned to near optimum to a depth of 18 inches below finish subgrade elevation and compacted to 90 percent relative compaction. A Type II/V cement may be used from a geotechnical perspective. Our flatwork and hardscape design considerations are presented in the table below.

Concrete Flatwork Table

Description	Subgrade Preparation (1)	Minimum Concrete Thickness	Cut-Off Barrier Or Edge Thickness	Joint Spacing (Maximum)	Concrete(3)
Concrete Sidewalks and Walkways (4)	1) 2 percent above optimum to 12"(1), 2) 2" of sand or well graded rock (i.e., Class II base or equiv.) above moisture conditioned subgrade.	4 inches	Not Required	5 feet	Type II/V
Concrete Driveways(4)	1) 2 percent above optimum to 12"(1), 2) 2" of sand or well graded rock (i.e., Class II base or equiv.) above moisture conditioned subgrade.	6 inches	Where adjacent to landscape areas – 12" from adjacent finish grade. Min. 8" width	10 feet	Type II/V

(1) The moisture content of the subgrade must be verified by the geotechnical consultant prior to sand/rock placement.
(2) Reinforcement to be placed at or above the mid-point of the slab (i.e., a minimum of 2.0 to 2.5 inches above the prepared subgrade).
(3) The site has negligible levels of sulfates as defined by the CBC. Concrete mix design is outside the geotechnical engineer's purview.
(4) Where flatwork is adjacent a stucco surface, a ¼" to ½" foam separation/expansion joint should be used.
(5) If dowels are placed in cored holes, the core holes shall be placed at alternating in-plane angles (i.e., not cored straight into slab).

Planters and Trees

Where new trees or large shrubs are to be located in close proximity to new concrete flatwork, rigid moisture/root barriers should be placed around the perimeter of the flatwork to at least 12 inches in depth in order to offer protection to the adjacent flatwork against potential root and moisture damage. Existing mature trees near flatwork areas should also incorporate a rigid moisture/root barrier placed at least 2 feet in depth below the top of the flatwork.

Drainage Control

The control of surface water is essential to the satisfactory performance of the building and site improvements. Surface water should be controlled so that conditions of uniform moisture are maintained beneath the improvements, even during periods of heavy rainfall. The following recommendations are considered minimal:

- Ponding and areas of low flow gradients should be avoided.
- If bare soil within 5 feet of the structure is not avoidable, then a gradient of 5 percent or more should be provided sloping away from the improvement. Corresponding paved surfaces should be provided with a gradient of at least 2 percent.
- The remainder of the unpaved areas should be provided with a drainage gradient of at least 2 percent.
- Positive drainage devices, such as graded swales, paved ditches, and/or catch basins should be employed to accumulate and to convey water to appropriate discharge points.
- Concrete walks and flatwork should not obstruct the free flow of surface water.
- Brick flatwork should be sealed by mortar or be placed over an impermeable membrane.
- Area drains should be recessed below grade to allow free flow of water into the basin.
- Enclosed raised planters should be sealed at the bottom and provided with an ample flow gradient to a drainage device. Recessed planters and landscaped areas should be provided with area inlet and subsurface drain pipes.
- Planters should not be located adjacent to the structures wherever possible. If planters are to be located adjacent to the structures, the planters should be positively sealed, should incorporate a subdrain, and should be provided with free discharge capacity to a drainage device.
- Planting areas at grade should be provided with positive drainage. Wherever possible, the grade of exposed soil areas should be established above adjacent paved grades. Drainage devices and curbing should be provided to prevent runoff from adjacent pavement or walks into planted areas.

- Gutter and downspout systems should be provided to capture discharge from roof areas. The accumulated roof water should be conveyed to off-site disposal areas by a pipe or concrete swale system.
- Landscape watering should be performed judiciously to preclude either soaking or desiccation of soils. The watering should be such that it just sustains plant growth without excessive watering. Sprinkler systems should be checked.

Plans and Specifications Review

The recommendations presented in this report are contingent upon review of final plans and specifications for the project by NTS. NTS Geotechnical, Inc. should review and verify in writing the compliance of the final grading plan and the final foundation plans with the recommendations presented in this report.

Construction Observation and Testing

It is recommended that NTS be retained to provide Geotechnical Consulting services during the earthwork operations and foundation installation process. This is to observe compliance with the design concepts, specifications and recommendations and to allow for design changes in the event that subsurface conditions differ from those anticipated during our subsurface investigation.

It is the responsibility of the owner and their representative to bring any deviations or unexpected conditions observed during construction to the attention of NTS Geotechnical, in order for supplemental recommendations can be made with a minimum delay to the project. Construction should be observed and/or testing at the following stages by NTS Geotechnical, Inc.:

- During all phases of precise grading, including over-excavation, temporary excavations, removals, scarification, ground preparation, moisture condition, proof-rolling, and placement and compaction of all fill material.
- All foundation excavation prior to placement of steel
- During backfill of underground utilities
- During placement of pavement structural section, including verifying the subgrade prior to placement of aggregate base, testing of aggregate base, and testing of asphalt concrete pavement.
- When unusual conditions are encountered.

If any of these inspections to verify site geotechnical conditions are not performed by NTS Geotechnical, liability for the safety and stability of the project is limited only to the actual portions of the project that is observed and approved by NTS Geotechnical.

LIMITATIONS

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

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

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

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

REFERENCES

American Concrete Institute, 2014, Building Code Requirements for Structural Concrete (ACI 318-14).

American Society of Civil Engineers (ASCE), 2017, Minimum Design Loads for Buildings and Other Structures, ASCE 7-16.

California Building Standards Commission, 2022, California Building Code, California Code of Regulations Title 24, Volume 2.

Coduto, Donald P., 1994, Foundation Design: Principles and Practices: Prentice-Hall, Inc, Englewood Cliffs, New Jersey.

Naval Facilities Engineering Command, 1986, NAVFAC Design Manual.

United States Geological Survey (USGS), 2008, Unified Hazard Tool, Dynamic: Conterminous U.S. 2014 (update) (v4.2.0), Retrieved May 14, 2020, from: https://earthquake.usgs.gov/hazards/interactive/

LOCATION MAP

NTS GEOTECHNICAL	Date:	July 03, 2023	Plate 1
	Project No.:	23230	

GEOTECHNICAL LEGEND

B-1 ● APPROXIMATE LOCATION OF BORING

P-1 ● APPROXIMATE LOCATION OF PERCOLATION/INFILTRATION

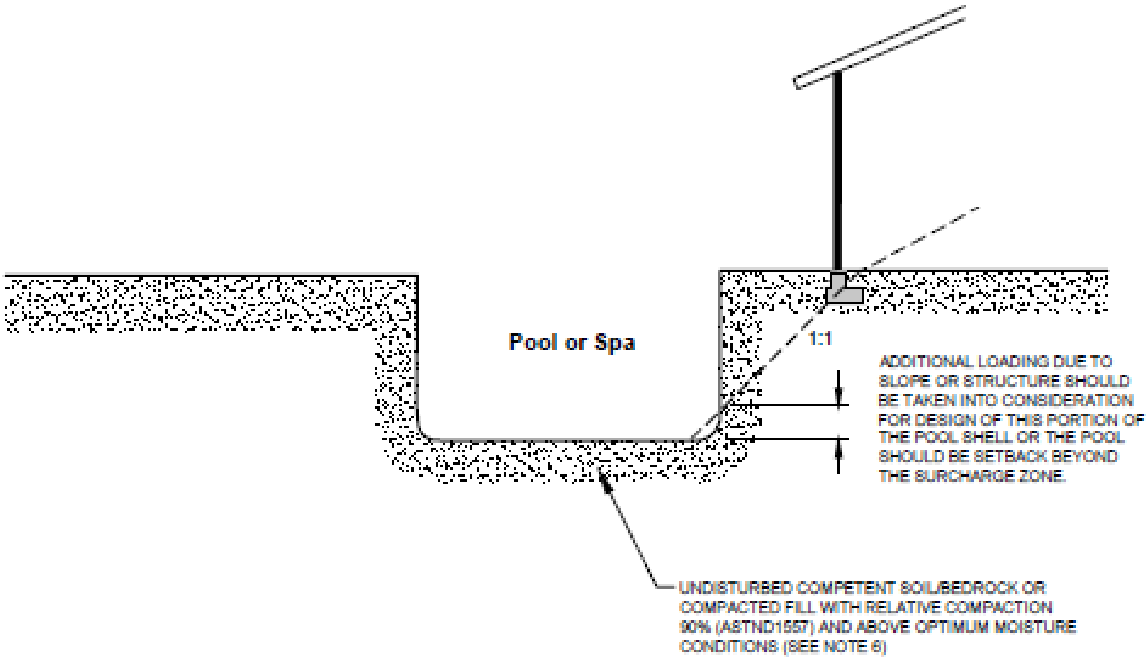
NTS GEOTECHNICAL

GEOTECHNICAL MAP

Date: 7/3/2023

Project No.: 23230

Plate: 2



1. THE POOL WALLS SHOULD BE DESIGNED TO ACCOUNT FOR THE FOLLOWING SOIL EXPANSION FORCES;
   - VERY LOW EXPANSION - EFP = 40 psf/ft
   - LOW EXPANSION - EFP = 50psf/ft
   - MEDIUM EXPANSION - EFP = 75psf/ft
   - HIGH TO VERY HIGH EXPANSION - EFP = 125psf/ft

   THE ACTUAL EXPANSIVENESS OF SOILS EXPOSED IN POOL EXCAVATION SHOULD BE EVALUATED UPON COMPLETION OF THE EXCAVATION AS POOL SUBGRADE SOILS ARE EXPOSED.

2. WHERE POOLS OR SPAS ARE PLANNED NEAR STRUCTURES, APPROPRIATE SURCHARGE LOADS SHOULD BE INCORPORATED INTO THE DESIGN AND CONSTRUCTION.

3. IN ORDER TO PROVIDE UNIFORM CONDITIONS, THE BOTTOM OF THE POOL EXCAVATION MAY NEED TO BE OVER-EXCAVATED AND REPLACED TO POOL SUBGRADE WITH COMPACTED FILL. AS AN ALTERNATIVE, THE REINFORCING STEEL IN THE ARE OF A TRANSITION ARE MAY BE INCREASED TO ACCOUNT FOR THE DIFFERENCES IN ENGINEERING PROPERTIES AND THE POTENTIAL DIFFERENTIAL BEHAVIOR.

4. WHEREAS POOL EXCAVATION MAY BE FREE OF WATER AT A TIME OF CONSTRUCTION, FUTURE IRRIGATION COULD RESULT IN THE DEVELOPMENT OF PERCHED WATER ZONES WHICH COULD AFFECT SUBSURFACE IMPROVEMENTS. HEAVY-DUTY PIPES AND FLEXIBLE COUPLINGS SHOULD BE USED FOR THE POOL PLUMBING SYSTEM TO MINIMIZE LEAKING WHICH MAY PRODUCE ADDITIONAL PRESSURES ON THE POOL SHELL. IN ADDITION, INSTALLATION OF A PRESSURE VALVE IN THE POOL BOTTOM SHOULD BE USED TO MITIGATE POTENTIAL BUILD-UP OF PRESSURE.

5. IN GENERAL, ALL BELOW GRADE IMPROVEMENTS MUST BE CONSTRUCTED BY QUALIFIED PROFESSIONALS UTILIZING APPROPRIATE DESIGNS WHICH ACCOUNT FOR THE ON-SITE (LOT) GEOTECHNICAL CONDITIONS. OBSERVATION/TESTING SHOULD BE PERFORMED BY NTS DURING POOL/SPA EXCAVATION TO VERIFY EXPOSED SOIL CONDITIONS ARE CONSISTENT WITH THE ASSUMED DESIGN CONDITIONS.

6. FOR HIGHLY/SEVERELY CORROSIVE SOILS, CEMENT SHALL BE TYPE V AND CONCRETE SHALL HAVE A MINIMUM WATER TO CEMENT RATIO OF 0.45 AND MINIMUM COMPRESSIVE STRENGTH OF 4,500 PSI. FOR MODERATELY CORROSIVE SOILS, CEMENT SHALL BE TYPE II/V, AND CONCRETE SHALL HAVE A MINIMUM WATER TO CEMENT RATIO OF 0.50 AND MINIMUM COMPRESSIVE STRENGTH OF 4,000 PSI. SPECIAL RECOMMENDATIONS MAY BE REQUIRED FOR VERY SEVERE LEVELS OF SULFATES. FINAL CONCRETE MIX DESIGN IN OUTSIDE OUR PURVIEW.

7. IT SHOULD BE NOTED THAT IMPLEMENTATION OF THE ABOVE RECOMMENDATIONS ONLY SERVE TO REDUCE THE POTENTIAL FOR EXPANSIVE SOIL RELATED MOVEMENTS INCLUDING SLOPE CREEP AND LATERAL FILL EXTENSION. THE RECOMMENDATIONS ARE NOT INTENDED TO ELIMINATE THESE TYPES OF MOVEMENTS. CONSEQUENTLY, SOME DISTORTION SHOULD BE ANTICIPATED.

DATE 7/05/2023	POOL AND SPA DESIGN	NTS GEOTECHNICAL	PLATE 3
DRAWN BY NS			

NTS GEOTECHNICAL

APPENDIX A

Field Exploration

Appendix A
Field Exploration

The subsurface exploration program for the proposed project consisted of advancing five (5) 4-inch-diameter, hand tool borings at the subject site. The borings advanced to depths ranging from 5.5 to 15.5 feet below the existing grade. The Boring Logs are presented within Appendix A-1.

The Boring Logs are presented as Figures A-2 to A-6. The Boring Logs describe the earth materials encountered, samples obtained, and show the field and laboratory tests performed. The log also shows the boring number, drilling date, and the name of the logger and drilling subcontractor. The borings were logged by an engineer using the Unified Soil Classification System. The boundaries between soil types shown on the logs are approximate because the transition between different soil layers may be gradual. Drive and bulk samples of representative earth materials were obtained from the borings.

A California modified sampler was used to obtain drive samples of the soil encountered. This sampler consists of a 3-inch outside diameter (O.D.), 2.4-inch inside diameter (I.D.) split barrel shaft that was driven a total of 6-inches into the soil at the bottom of the boring by a safety hammer. The soil was retained in brass rings for laboratory testing. Additional soil from each drive remaining in the cutting shoe was usually discarded after visually classifying the soil.

Upon completion of the borings, the boreholes were backfilled with soil from the cuttings.

Project: **063003105 & 063003106** Project Location: **063003105 & 063003106, Landers** Project Number: **23230**	NTS GEOTECHNICAL	Key to Log of Boring **Sheet 1 of 1**

Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	REMARKS AND OTHER TESTS
1	2	3	4	5	6	7	8	9

COLUMN DESCRIPTIONS

1 Depth (feet): Depth in feet below the ground surface.
2 Sample Type: Type of soil sample collected at the depth interval shown.
3 Sampling Resistance, blows/ft: Number of blows to advance driven sampler one foot (or distance shown) beyond seating interval using the hammer identified on the boring log.
4 Material Type: Type of material encountered.
5 Graphic Log: Graphic depiction of the subsurface material encountered.
6 MATERIAL DESCRIPTION: Description of material encountered. May include consistency, moisture, color, and other descriptive text.
7 Water Content, %: Water content of the soil sample, expressed as percentage of dry weight of sample.
8 Dry Unit Weight, pcf: Dry weight per unit volume of soil sample measured in laboratory, in pounds per cubic foot.
9 REMARKS AND OTHER TESTS: Comments and observations regarding drilling or sampling made by driller or field personnel.

FIELD AND LABORATORY TEST ABBREVIATIONS

CHEM: Chemical tests to assess corrosivity
COMP: Compaction test
CONS: One-dimensional consolidation test
LL: Liquid Limit, percent
PI: Plasticity Index, percent
SA: Sieve analysis
DS: Direct Shear
EI: Expansion Index
WA: Wash sieve (percent passing No. 200 Sieve)

MATERIAL GRAPHIC SYMBOLS

Silty SAND (SM)
Poorly graded SAND with Silt (SP-SM)

TYPICAL SAMPLER GRAPHIC SYMBOLS

Auger sampler
CME Sampler
Pitcher Sample
Bulk Sample
Grab Sample
2-inch-OD unlined split spoon (SPT)
3-inch-OD California w/ brass rings
2.5-inch-OD Modified California w/ brass liners
Shelby Tube (Thin-walled, fixed head)

OTHER GRAPHIC SYMBOLS

Water level (at time of drilling, ATD)
Water level (after waiting, AW)
Minor change in material properties within a stratum
Inferred/gradational contact between strata
—?— Queried contact between strata

GENERAL NOTES

1: Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive, and actual lithologic changes may be gradual. Field descriptions may have been modified to reflect results of lab tests.
2: Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced. They are not warranted to be representative of subsurface conditions at other locations or times.

C:\Users\info\NTS GEOTECHNICAL\Projects - General\2023\23230 - APN 063003105 & 063003106, Landers\Reports\SOILS\APPENDIX A\23230 Boring Log B-1 to B-5.bg4[NTS Template 1-9-21.tpl]

Project: **063003105 & 063003106** Project Location: **063003105 & 063003106, Landers** Project Number: **23230**	NTS GEOTECHNICAL	# Log of Boring B-1 **Sheet 1 of 1**

Date(s) Drilled **6/23/23**	Logged By **LB**	Checked By **NS**
Drilling Method **Hand Tools**	Drill Bit Size/Type **5"**	Total Depth of Borehole **10.5 feet**
Drill Rig Type **Hand Tools**	Drilling Contractor **Juan Garcia**	Approximate Surface Elevation **N/A**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **Modified California**	Hammer Data **N/A**
Borehole Backfill **Native**	Location **063003105 & 063003106, Landers**	

Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	REMARKS AND OTHER TESTS
0			SM		ALLUVIUM (Qa): SILTY SAND, fine-grained sand, dry, loose, brown			
	■					1	108.2	
5	■		SM		dry, medium dense to dense	12	110.7	
10	■		SM		some gravel, dry	2.2	105.9	
					Total Depth = 10.5 feet Groundwater not encountered Backfilled with native			
15								

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Project: **063003105 & 063003106** Project Location: **063003105 & 063003106, Landers** Project Number: **23230**	NTS GEOTECHNICAL	# Log of Boring B-5 **Sheet 1 of 1**

Date(s) Drilled **6/23/23**	Logged By **LB**	Checked By **NS**
Drilling Method **Hand Tools**	Drill Bit Size/Type **5"**	Total Depth of Borehole **10.5 feet**
Drill Rig Type **Hand Tools**	Drilling Contractor **Juan Garcia**	Approximate Surface Elevation **N/A**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **Modified California**	Hammer Data **N/A**
Borehole Backfill **Native**	Location **063003105 & 063003106, Landers**	

Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	REMARKS AND OTHER TESTS
0			SM		ALLUVIUM (Qa): SILTY SAND, fine-grained sand, damp, loose, brown			
	■					3.5	102.1	
5	■		SM		some gravel, dry, dense	2.3	108.9	
10	■		SM		dry	2.2		
					Total Depth = 10.5 feet Groundwater not encountered Backfilled with native			
15								

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Figure A-7

Project: **063003105 & 063003106**		Log of Boring B-3
Project Location: **063003105 & 063003106, Landers**	NTS GEOTECHNICAL	**Sheet 1 of 2**
Project Number: **23230**		

Date(s) Drilled **6/23/23**	Logged By **LB**	Checked By **NS**
Drilling Method **Hand Tools**	Drill Bit Size/Type **5"**	Total Depth of Borehole **10.5 feet**
Drill Rig Type **Hand Tools**	Drilling Contractor **Juan Garcia**	Approximate Surface Elevation **N/A**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **Modified California**	Hammer Data **N/A**
Borehole Backfill **Native**	Location **063003105 & 063003106, Landers**	

Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	REMARKS AND OTHER TESTS
0			SM		ALLUVIUM (Qa): SILTY SAND, fine-grained sand, loose, brown			
2	■		SM		some gravel, damp, dense	5.4	103.7	
5	■		SP-SM		ALLUVIUM (Qa): SAND TO SILTY SAND, fine-grained sand, dry, medium dense, brown	1.7		
10	■		SM		ALLUVIUM (Qa): SILTY SAND, fine-grained sand, some gravel and very silty, damp, medium dense, brown	3.5	109.6	
15								

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Figure A-5

Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	REMARKS AND OTHER TESTS
15	■		SM		damp	3.1	106.2	
					Total Depth = 15.5 feet Groundwater not encountered Backfilled with native			
20								
25								
30								
35								
40								
45								
50								

Project: **063003105 & 063003106** Project Location: **063003105 & 063003106, Landers** Project Number: **23230**	NTS GEOTECHNICAL	Log of Boring B-2 **Sheet 1 of 1**

Date(s) Drilled **6/23/23**	Logged By **LB**	Checked By **NS**
Drilling Method **Hand Tools**	Drill Bit Size/Type **5"**	Total Depth of Borehole **5.5 feet**
Drill Rig Type **Hand Tools**	Drilling Contractor **Juan Garcia**	Approximate Surface Elevation **N/A**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **Modified California**	Hammer Data **N/A**
Borehole Backfill **Native**	Location **063003105 & 063003106, Landers**	

Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	REMARKS AND OTHER TESTS
0			SM		ALLUVIUM (Qa): SILTY SAND, fine-grained sand, dry, loose, brown			
	■		SM		some gravel, dry, dense	1.7	109.7	
5	■		SM		dry	2.0	112.8	
					Total Depth = 5.5 feet Groundwater not encountered Backfilled with native			
10								
15								

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Figure A-4

Project: **063003105 & 063003106** Project Location: **063003105 & 063003106, Landers** Project Number: **23230**	NTS GEOTECHNICAL	Log of Boring B-4 **Sheet 1 of 1**

Date(s) Drilled **6/23/23**	Logged By **LB**	Checked By **NS**
Drilling Method **Hand Tools**	Drill Bit Size/Type **5"**	Total Depth of Borehole **5.5 feet**
Drill Rig Type **Hand Tools**	Drilling Contractor **Juan Garcia**	Approximate Surface Elevation **N/A**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **Modified California**	Hammer Data **N/A**
Borehole Backfill **Native**	Location **063003105 & 063003106, Landers**	

Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	REMARKS AND OTHER TESTS
0			SM		ALLUVIUM (Qa): SILTY SAND, fine-grained sand, some gravel, dry, loose, brown			
	■		SM		dry, dense	2.1	110.1	
5	■		SM		dry, medium dense	2.2	116.8	
					Total Depth = 5.5 feet Groundwater not encountered Backfilled with native			
10								
15								

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NTS GEOTECHNICAL

APPENDIX B

Laboratory Testing Data

NTS GEOTECHNICAL

Appendix B
Geotechnical Laboratory Testing

Laboratory Moisture Content and Density Tests

The moisture content and dry densities of selected driven samples obtained from the exploratory boring was evaluated in general accordance with the latest version of ASTM D 2937. The test results are presented on the log of the exploratory boring in Appendix A.

Wash Sieve

The number of fines passing the No. 200 sieve was evaluated by the wash sieve. The test procedure was in general accordance with ASTM D 1140. The results are attached to this Appendix B.

Boring No.	Depth (ft)	Fines Passing No. 200, %
B-1	2	16.2
B-1	5	20.7
B-1	10	17.3
B-2	2	12.0
B-2	5	20.4
B-3	2	14.9
B-3	5	11.6
B-3	10	18.2
B-3	15	15.7
B-4	2	18.4
B-4	5	22.1
B-5	2	13.4
B-5	5	13.2
B-5	10	33.2

Gradation Test

The number of fines of a sample passing the No. 200 sieve was evaluated by assembling a group of sieves with a collecting pan at the bottom. The test procedure was in general accordance with ASTM D 6913. The results are attached to this Appendix B.

Direct Shear Tests

Direct shear tests were performed on selected remolded and relatively undisturbed soil samples in general accordance with ASTM D 3080 to evaluate the shear strength characteristics of the materials. The samples were inundated during shearing to represent adverse field conditions. Direct shear test results are attached to this Appendix B.

Consolidation Test

Consolidation tests was performed on a selected driven soil sample in general accordance with the latest version of ASTM D2435. The sample was inundated during testing to represent adverse field conditions. The percent consolidation for each load cycle was recorded as a ratio of the amount of vertical compression to the original height of the sample. Consolidation testing results are attached to this Appendix B.

Corrosion Suite

The corrosion potential of typical on-site materials under long-term contact with both metal and concrete was determined by chemical and electrical resistance tests. The soluble sulfate test for potential concrete corrosion was performed in general accordance with ASTM D4327. The test results are attached to this Appendix B.

GRADATION TEST RESULTS

Date Tested: 6/18/2023

USCS	GRAVEL		SAND			FINES	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Boring No.	Sample No.	Depth (ft)	Passing 200 (%)	USCS Classification
P-1	Bulk	2'-4'	19.3	#NAME?

Sample Description	Brown #NAME?	**Moisture Percent**	1.1

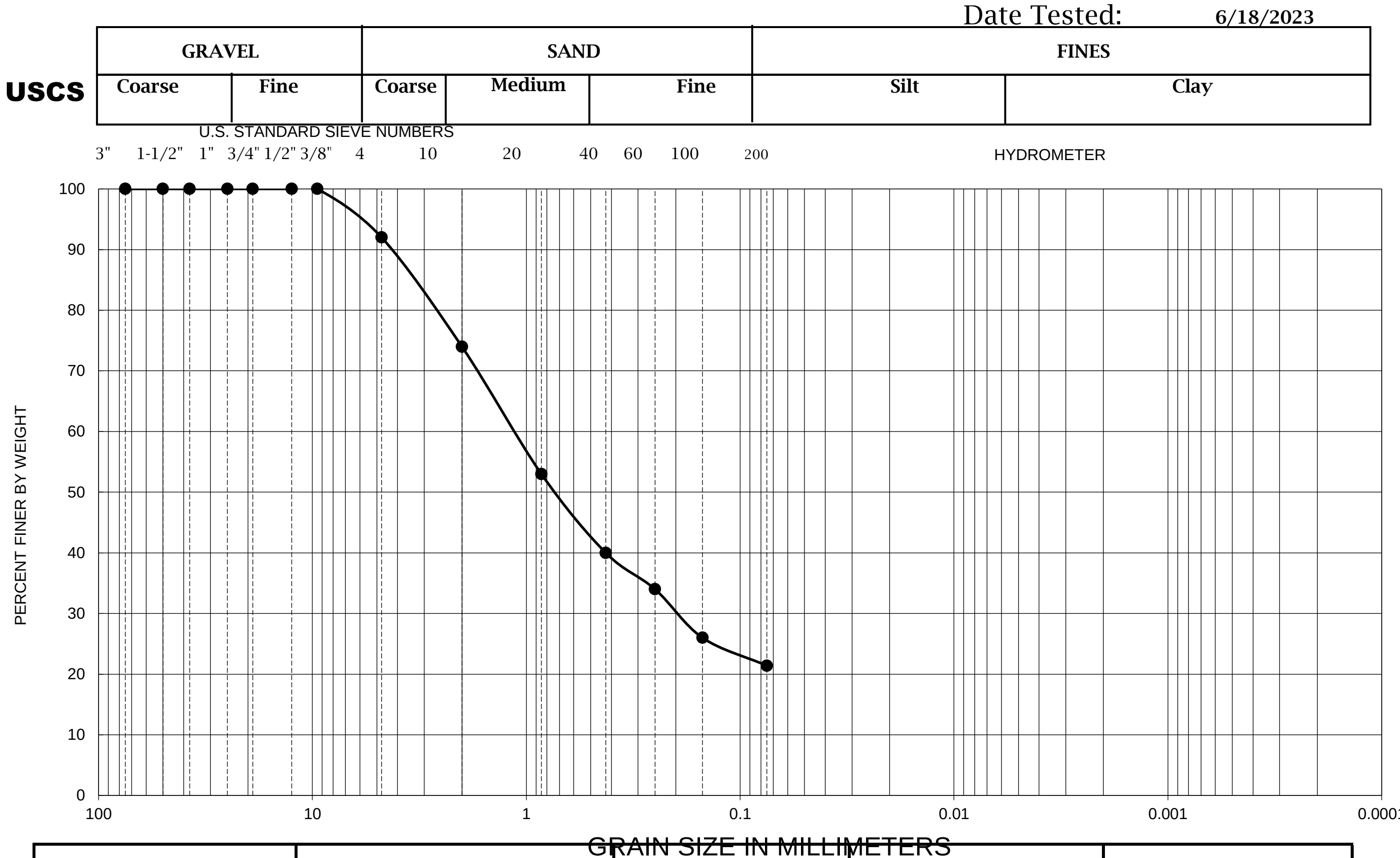
	Sieve Size		% Passing
Sieve Analysis	2"	50 mm	100
	1.5"	37.5 mm	100
	1"	25 mm	100
	3/4"	19 mm	100
	1/2"	12.5 mm	100
	3/8"	9.5 mm	99
	No. 4	4.75 mm	89
	No. 10	2.0 mm	65
	No. 20	0.85 mm	48
	No. 40	0.425 mm	39
	No. 60	0.25 mm	29
	No 100	0.15 mm	25
	No 200	.075 mm	19.3

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 6913

NTS GEOTECHNICAL				Project Name	Figure
Project #	23230	Tech:	LB	**Belfield Blvd**	**B-1**

GRADATION TEST RESULTS

Date Tested: 6/18/2023



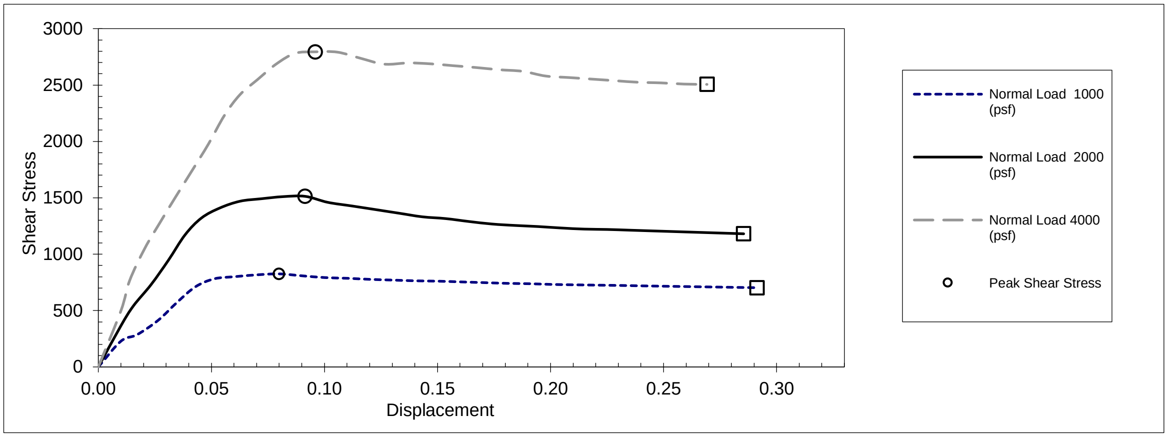
Boring No.	Sample No.	Depth (ft)	Passing 200 (%)	USCS Classification
P-4	Bulk	2'-4'	21.4	#NAME?

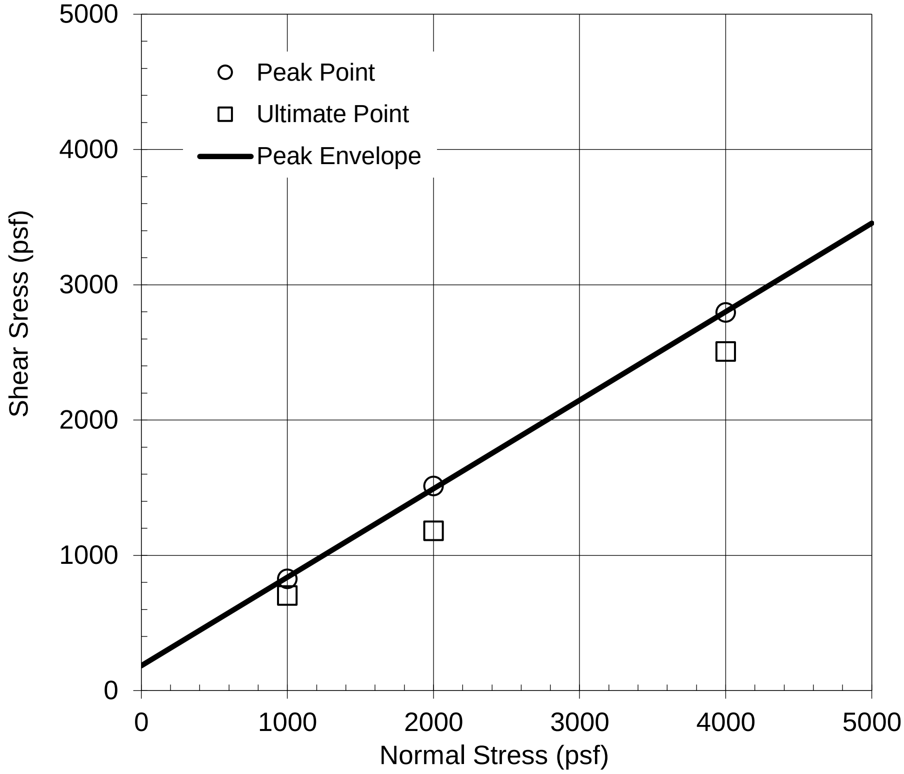
Sample Description	Brown #NAME?	Moisture Percent	1.6

	Sieve Size		% Passing
Sieve Analysis	2"	50 mm	100
	1.5"	37.5 mm	100
	1"	25 mm	100
	3/4"	19 mm	100
	1/2"	12.5 mm	100
	3/8"	9.5 mm	100
	No. 4	4.75 mm	92
	No. 10	2.0 mm	74
	No. 20	0.85 mm	53
	No. 40	0.425 mm	40
	No. 60	0.25 mm	34
	No 100	0.15 mm	26
	No 200	.075 mm	21.4

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 6913

NTS GEOTECHNICAL	Project Name	Figure
Project # 23230 Tech: LB	**Belfield Blvd**	**B-2**





Strain Rate =	0.0118	inch/min		Interpreted Shear Strength			
Date Tested:	6/24/2023			Peak		Ultimate	
Boring No.	Sample No.	Depth	UCSC	Cohesion (psf)	Friction Angle (deg)	Cohesion (psf)	Friction Angle (deg)
B-1	1	5	SM	184	33.2	40	31.4
Sample description:		Brown Silty Sand					

NTS GEOTECHNICAL

Direct Shear Test Results

Figure

Belfield Blvd.

B-3

Tech: LB

Project # 23230

3-Jul-23

Date Tested	6/23/2023			
Boring No.	B-2			
Depth, ft.	5			
Sample Description	Brown Silty Sand			
Soil Condition	Before	After		
Weight Wet Sample and Ring, g	177.5	195.0		
Weight Dry Sample and Ring	175.0	175.0		
Weight Ring, g	40.9	40.9		
Weight Dry Sample	134.1	134.1		
Moisture Content, %	1.9	14.9		
Wet Density, lbs/cu. ft.	113.1	128.4		
Dry Density, lbs/cu. ft.	111.1	111.8		
Void Ratio	0.49	0.48		
Saturation, %	10.1	82.4		
Consolidation Data				
Load, psf	1000	1000		
Initial Height, in.	1.0000			
Final Height, in.		0.9937		
Consolidation % of Sample Height	**0.6**			

NTS GEOTECHNICAL

Project # 23230 Tech L.B.

Consolidation Test

Belfield Blvd

FIGURE

B-4

Date Tested	6/25/2023			
Boring No.	B-3			
Depth, ft.	10			
Sample Description	Brown Silty Sand			
Soil Condition	Before	After		
Weight Wet Sample and Ring, g	179.4	198.4		
Weight Dry Sample and Ring	175.1	175.1		
Weight Ring, g	41.1	41.1		
Weight Dry Sample	134.0	134.0		
Moisture Content, %	3.2	17.4		
Wet Density, lbs/cu. ft.	114.5	132.6		
Dry Density, lbs/cu. ft.	111.0	113.0		
Void Ratio	0.49	0.46		
Saturation, %	17.4	99.4		
Consolidation Data				
Load, psf	1000	1000		
Initial Height, in.	1.0000			
Final Height, in.		0.9823		
Consolidation % of Sample Height	**1.8**			

NTS GEOTECHNICAL

Project # 23230 Tech L.B.

Consolidation Test

Belfield Blvd

FIGURE

B-5

Soil Analysis Lab Results

Client: NTS Geotechnical
Job Name: Belfield Boulevard, Landers
Client Job Number: X
Project X Job Number: S230626C
June 27, 2023

	Method	ASTM D4327		ASTM D4327		ASTM G187		ASTM G51
Bore# / Description	**Depth**	**Sulfates** SO_4^{2-}		**Chlorides** Cl^-		**Resistivity** As Rec'd | Minimum		**pH**
	(ft)	(mg/kg)	(wt%)	(mg/kg)	(wt%)	(Ohm-cm)	(Ohm-cm)	
B-1 Brown silty sand	2-5	23.2	0.0023	12.3	0.0012	>737,000	14,070	7.3

Cations and Anions, except Sulfide and Bicarbonate, tested with Ion Chromatography
mg/kg = milligrams per kilogram (parts per million) of dry soil weight
ND = 0 = Not Detected | NT = Not Tested | Unk = Unknown
Chemical Analysis performed on 1:3 Soil-To-Water extract
PPM = mg/kg (soil) = mg/L (Liquid)

Note: Sometimes a bad sulfate hit is a contaminated spot. Typical fertilizers are Potassium chloride, ammonium sulfate or ammonium sulfate nitrate (ASN). So this is another reason why testing full corrosion series is good because we then have the data to see if those other ingredients are present meaning the soil sample is just fertilizer-contaminated soil. This can happen often when the soil samples collected are simply surface scoops which is why it's best to dig in a foot, throw away the top and test the deeper stuff. Dairy farms are also notorious for these items.

July 5, 2023

Project No. 23230.1

Belfield Developments, LLC
Attn: Mr. Sam Friedman
APN 063003105 & 063003106
Landers, CA

Subject: Percolation Report
Proposed Hotel
APN 685-100-007 & 685-110-017
City of Landers, County of San Bernardino, California

Dear Mr. Friedman:

In accordance with your request and authorization, we are presenting the results of our percolation investigation for the proposed hotel to be constructed at APN 685-100-007 and 685-110-017, in the City of Landers, County of San Bernardino, California. The purpose of this investigation has been to evaluate the subsurface conditions at the site and to provide geotechnical recommendations and percolation test data for design and construction of proposed septic system.

Based on our findings, the proposed project is geotechnically feasible, provided that the recommendations in this report are incorporated into the design and are implemented during construction of the project. This report was prepared in accordance with the requirements of the 2022 California Plumbing Code and the County of San Bernardino requirements.

We appreciate the opportunity to be of service on this project. Should you have any questions regarding this report or if we can be of further service, please do not hesitate to contact the undersigned at (657) 888-4608 or info@ntsgeo.com.

Respectfully submitted,
NTS GEOTECHNICAL, INC.

Nadim Sunna, M.Sc., Q.S.P, P.E., G.E. 3172
Principal Engineer

Attachment(s):

Plate 1 – Location Map
Plate 2 – Plot Plan

Appendix A – Field Exploration
Appendix B – Geotechnical Laboratory Test Result
Appendix C – Percolation Test Result
Appendix D – Leachline Calculations

1. **DESCRIPTION OF SITE AND OF PROPOSAL:**

1.1 Date County Specialist Notified: June 20, 2023, Notified by Mr. Nadim Sunna via email to ehs.customerservice@dph.sbcounty.gov

1.2 Prepared for: **Belfield Developments, LLC**
Attn: Mr. Sam Friedman
APN 063003105 & 063003106
Landers, CA

1.3 Location of Land: The site is located at APN 063003105 & 063003106, in the Landers area of the County of San Bernardino, California. See attached Plate 1 – Location Map.

1.4 Proposed Development/Project/Land Use:

a) Type of Project: The project consists of construction of one story hotel, restaurant and meeting area, pool area, and associated site improvements. Based on our correspondence with the project architect, we understand the following fixtures are anticipated:

Fixture	No. of Fixture	Fixture Units
Water Closet	55	220
Urinal	5	10
Lavatory	45	45
Tub/ Shower	40	80
Drinking Fountains	5	3
Kitchen sink – compartment	3	6
Kitchen hand sink	8	24
Dishwasher	1	2
Water station	4	2
Mop sinks	2	9
Laundry Machine	5	10
Hose Bibs	10	20
	TOTAL:	431

The location of the structures are shown Plate 2 – Plot Plan.

b) 1. Acreage: The total area of the site is approximately 8.73 Acres. The area available for the system is approximately 1 acre located in the norther and eastern side of the property.

2. Number of lots: Two.

3. Lot density: One lot per 4.5 acres.

c) Type of Sewage Disposal: A septic tank and leach field system was proposed.

d) Grading: Some grading is required for the project to develop the driveway leading to the building pad and the building pads.

1.5 Description of Site and Surroundings:

a) Topography: The area of the proposed leachfield system is gently sloping with an approximate 2 foot difference in elevation over approximately 100 feet going from east to west.

b) Water Courses: Based on review of available survey and google earth images, no water courses cross the site or located within 50 feet of the site. The closest portion of the Pipos Wash on the easter side of the site is about 87 feet from the eastern property line.

c) Vegetation Type and Density: Light growth of weeds and native plants.

d) Existing Structures: None in the system area.

e) Existing Wells or Abandoned Wells on or Within 300 Feet of Project: None known.

f) Rock Outcrops: No bedrock outcrops were observed.

g) Probable Depth to Water Table:

Groundwater was not observed during our exploration to a maximum depth of 15.5 feet below the existing grade. Based on our review of nearby well data (Well No. 342678N1164075W001) we note that the highest groundwater was recorded at an elevation of 2939, which places groundwater at depth of over 110 feet below existing grade. Groundwater conditions may vary across the site due to stratigraphic and hydrologic conditions, and may change over time as a consequence of seasonal and meteorological fluctuations, or activities by humans at this site and nearby sites. However, based on the above findings, groundwater is unlikely to impact the proposed development.

h) Any Other Features That May Affect Sewage Disposal: None. The proposed system will be entirely within native materials.

2. EQUIPMENT:

2.1 Exploration: The soil conditions underlying the subject site were previously explored by means of five (5) exploratory borings excavated to a maximum depth of 15 feet bgs with hand tools. Our exploration log is presented within Appendix A.

2.2 Percolation Tests: Four percolation tests were performed on site to a depth of 4 to 6 feet bgs. Approximately two inches of gravel was placed at the bottom of each hole.

3. METHODOLOGY AND PROCEDURES:

3.1 Location of Exploratory Boring: See attached Plate 2 – Plot Plan.

3.2 Soil Characteristics to Determine Number of Borings: The investigation was based on a favorable soil classification.

3.3 Minimum Number of Exploratory Borings: Per San Bernardino County Department of Environmental Health Service Soil Percolation Test Report Standards, a minimum of one exploratory boring is required. For the purposes of this percolation report, four exploratory borings were excavated onsite.

3.3.1 Exploratory Boring Results: Our exploratory boring logs are presented within Appendix A. The near surface native soils generally consist of silty sands (SM).

3.3.2 Laboratory Test Results: Our laboratory test results are presented within Appendix B of this report.

3.4 Tests for Leachlines: A minimum of four percolation tests are required for favorable soil conditions. Four percolation tests were performed for the proposed leachfield. The percolation test holes were excavated using an 6-inch diameter hand auger.

3.4.1 Standard Percolation Test Procedure for Leachlines:

Test holes: In accordance with the Standard Percolation Test Procedure for Leachlines, Environmental Health Services, San Bernardino County, California, dated June 2017 the percolation tests were performed within 12 inches of the anticipated depth of the leachlines.

The test holes were pre-soaked by inverting a full 5 gallon bottle of water over the test hole. Testing was performed the following day, due to two consecutive measurements showing 6 inches of water did seep away in 25 minutes.

Measurement of the Percolation Rate: Readings were attempted the following day in 10-minute intervals. Based on our site observation, it is our recommendation to use a conservative percolation rate of 5 minutes per inch and an application rate of 0.83 gallons per day per square foot.

3.4.2 Leachline Test Results: See the attached percolation test data sheets (Appendix C)

4. <u>DISCUSSION OF RESULTS</u>:

4.1 Soils: The soil conditions as encountered within the exploratory boring and test holes were generally uniform. The near surface native soils generally consist of silty sands (SM). The soil conditions should be considered to be favorable.

4.2 Possible Sources of Error: Tests were performed in clean native soils. The material was generally uniform in nature. No other possible sources of error were noted.

4.3 Interpretation of Results: Results were generally as anticipated, based on the classification of the soils encountered.

5. DESIGN:

5.1 General Criteria

5.1.1 Percolation Rates: The recommended percolation rates for the proposed leach field is determined to be 5 minutes per inch (mpi).

5.1.2 The separation between the bottom of the proposed system and the groundwater level will exceed 40 feet based on data described above.

5.2 Convert Percolation Rates to Leachline Design Rates: For a percolation rate of 5 minutes per inch, the leach field will require a design rate of 55 sf/100/gstc.

5.3 Based on total number of fixtures consisting of 431 units, the recommended minimum size of the septic tank shall be 15,000 gallons.

5.4 Based on design rate of 55 sf/100/gstc, a minimum tank size of 15,000 gallons, we have determined the minimum lengths of leachlines for 3-foot-wide trenches at various gravel depths. The calculation for the trench lengths are provided within Appendix D of this report.

5.5 Based on our calculations and assumptions made above, we recommend at minimum that the septic dispersal system consisting of a minimum of 17 leachlines trenches that are 91 feet long with a rock depth of 3 feet.

6. PLOT PER CURRENTLY ADOPTED UNIFORM PLUMBING CODE:

Percolation testing was performed in the provided area of the leachfield as determined by others. Additional details such as design of the septic system, including location of the system, should be designed by an engineer competent in disposal system design.

7. GENERAL DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS:

7.1 Leachline disposal systems for the site should be constructed in accordance with current DEHS criteria and applicable portions of the Uniform Plumbing Code. All pertinent requirements of the Regional Water Quality Control Board should be met.

7.2 According to all information available to this firm, the proposed system area contains sufficient area to handle the liquid wastes, provided proper design is achieved. It is our opinion that there is sufficient area at the site for system installation, in addition to a 100 percent expansion area.

7.3 If more than one leachfield is needed for a disposal system at the site, the system should be designed by an engineer competent in disposal system design, or a properly installed distribution box should be utilized to balance flow and equalize the distribution of effluent to each leach line in lieu of such a design. Based upon the rates obtained and the anticipated usage of the site, sewage mounding should not be a concern.

7.4 A copy of this report should be submitted to DEHS for their review and assignment of the final application rate.

7.5 A copy of the San Bernardino County's DEHS handout "Taking Care of Your Septic System" should be obtained and utilized.

8. LIMITATIONS

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

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

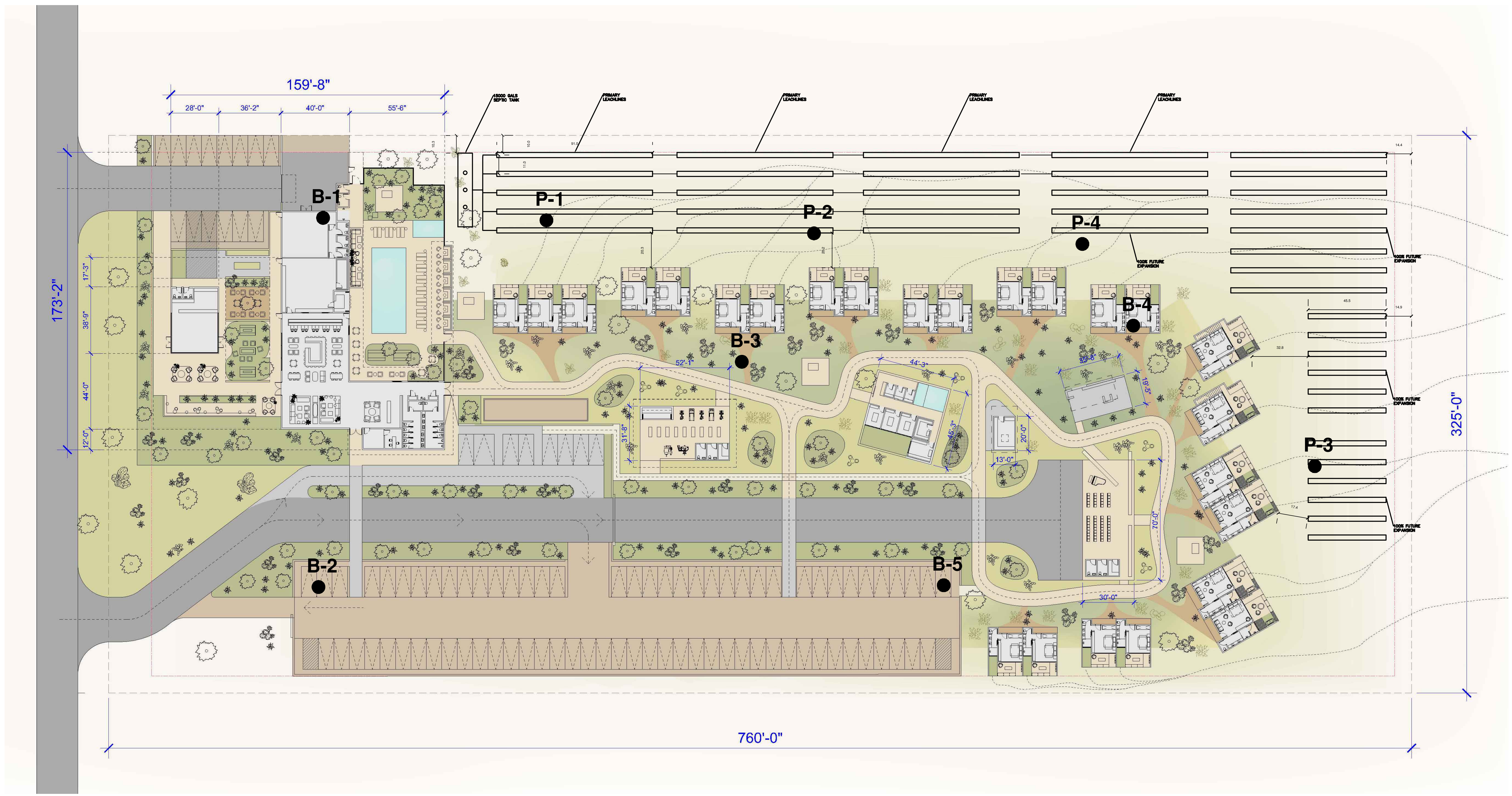
It should be further noted that the recommendations presented herein are intended solely to minimize the effects of post-construction soil movements. Consequently, minor cracking and/or distortion of all on-site improvements should be anticipated.

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

LOCATION MAP

NTS GEOTECHNICAL

Date:	July 03, 2023	Plate 1
Project No.:	23230	



NTS GEOTECHNICAL

GEOTECHNICAL LEGEND

B-1 ●	APPROXIMATE LOCATION OF BORING
P-1 ●	APPROXIMATE LOCATION OF PERCOLATION/INFILTRATION

PLOT PLAN

Date: 7/3/2023 | Project No.: 23230 | Plate: 2

NTS GEOTECHNICAL

APPENDIX A

Field Exploration

Appendix A
Field Exploration

The subsurface exploration program for the proposed project consisted of advancing five (5) 4-inch-diameter, hand tool borings at the subject site. The borings advanced to depths ranging from 5.5 to 15.5 feet below the existing grade. The Boring Logs are presented within Appendix A-1.

The Boring Logs are presented as Figures A-2 to A-6. The Boring Logs describe the earth materials encountered, samples obtained, and show the field and laboratory tests performed. The log also shows the boring number, drilling date, and the name of the logger and drilling subcontractor. The borings were logged by an engineer using the Unified Soil Classification System. The boundaries between soil types shown on the logs are approximate because the transition between different soil layers may be gradual. Drive and bulk samples of representative earth materials were obtained from the borings.

A California modified sampler was used to obtain drive samples of the soil encountered. This sampler consists of a 3-inch outside diameter (O.D.), 2.4-inch inside diameter (I.D.) split barrel shaft that was driven a total of 6-inches into the soil at the bottom of the boring by a safety hammer. The soil was retained in brass rings for laboratory testing. Additional soil from each drive remaining in the cutting shoe was usually discarded after visually classifying the soil.

Upon completion of the borings, the boreholes were backfilled with soil from the cuttings.

Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	REMARKS AND OTHER TESTS
1	2	3	4	5	6	7	8	9

COLUMN DESCRIPTIONS

1. Depth (feet): Depth in feet below the ground surface.
2. Sample Type: Type of soil sample collected at the depth interval shown.
3. Sampling Resistance, blows/ft: Number of blows to advance driven sampler one foot (or distance shown) beyond seating interval using the hammer identified on the boring log.
4. Material Type: Type of material encountered.
5. Graphic Log: Graphic depiction of the subsurface material encountered.
6. MATERIAL DESCRIPTION: Description of material encountered. May include consistency, moisture, color, and other descriptive text.
7. Water Content, %: Water content of the soil sample, expressed as percentage of dry weight of sample.
8. Dry Unit Weight, pcf: Dry weight per unit volume of soil sample measured in laboratory, in pounds per cubic foot.
9. REMARKS AND OTHER TESTS: Comments and observations regarding drilling or sampling made by driller or field personnel.

FIELD AND LABORATORY TEST ABBREVIATIONS

CHEM: Chemical tests to assess corrosivity
COMP: Compaction test
CONS: One-dimensional consolidation test
LL: Liquid Limit, percent
PI: Plasticity Index, percent
SA: Sieve analysis
DS: Direct Shear
EI: Expansion Index
WA: Wash sieve (percent passing No. 200 Sieve)

MATERIAL GRAPHIC SYMBOLS

Silty SAND (SM)

Poorly graded SAND with Silt (SP-SM)

TYPICAL SAMPLER GRAPHIC SYMBOLS

Auger sampler
Bulk Sample
3-inch-OD California w/ brass rings
CME Sampler
Grab Sample
2.5-inch-OD Modified California w/ brass liners
Pitcher Sample
2-inch-OD unlined split spoon (SPT)
Shelby Tube (Thin-walled, fixed head)

OTHER GRAPHIC SYMBOLS

Water level (at time of drilling, ATD)
Water level (after waiting, AW)
Minor change in material properties within a stratum
Inferred/gradational contact between strata
? Queried contact between strata

GENERAL NOTES

1: Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive, and actual lithologic changes may be gradual. Field descriptions may have been modified to reflect results of lab tests.
2: Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced. They are not warranted to be representative of subsurface conditions at other locations or times.

Project: **063003105 & 063003106**	NTS GEOTECHNICAL	Log of Boring B-1
Project Location: **063003105 & 063003106, Landers**		**Sheet 1 of 1**
Project Number: **23230**		

Date(s) Drilled **6/23/23**	Logged By **LB**	Checked By **NS**
Drilling Method **Hand Tools**	Drill Bit Size/Type **5"**	Total Depth of Borehole **10.5 feet**
Drill Rig Type **Hand Tools**	Drilling Contractor **Juan Garcia**	Approximate Surface Elevation **N/A**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **Modified California**	Hammer Data **N/A**
Borehole Backfill **Native**	Location **063003105 & 063003106, Landers**	

Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	REMARKS AND OTHER TESTS
0			SM		ALLUVIUM (Qa): SILTY SAND, fine-grained sand, dry, loose, brown			
	■					1	108.2	
5	■		SM		dry, medium dense to dense	12	110.7	
10	■		SM		some gravel, dry	2.2	105.9	
					Total Depth = 10.5 feet Groundwater not encountered Backfilled with native			
15								

C:\Users\info\NTS GEOTECHNICAL\Projects - General\2023\23230 - APN 063003105 & 063003106, Landers\Reports\SOILS\APPENDIX A\23230 Boring Log B-1 to B-5.bg4[NTS Template 1-9-21.tpl]

Figure A-3

Project: **063003105 & 063003106**		# Log of Boring B-5
Project Location: **063003105 & 063003106, Landers**	NTS GEOTECHNICAL	**Sheet 1 of 1**
Project Number: **23230**		

Date(s) Drilled **6/23/23**	Logged By **LB**	Checked By **NS**
Drilling Method **Hand Tools**	Drill Bit Size/Type **5"**	Total Depth of Borehole **10.5 feet**
Drill Rig Type **Hand Tools**	Drilling Contractor **Juan Garcia**	Approximate Surface Elevation **N/A**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **Modified California**	Hammer Data **N/A**
Borehole Backfill **Native**	Location **063003105 & 063003106, Landers**	

Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	REMARKS AND OTHER TESTS
0			SM		ALLUVIUM (Qa): SILTY SAND, fine-grained sand, damp, loose, brown			
2–2.5	■					3.5	102.1	
5	■		SM		some gravel, dry, dense	2.3	108.9	
10	■		SM		dry	2.2		
10.5					Total Depth = 10.5 feet Groundwater not encountered Backfilled with native			
15								

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Figure A-7

Project: **063003105 & 063003106** Project Location: **063003105 & 063003106, Landers** Project Number: **23230**	NTS GEOTECHNICAL	# Log of Boring B-3 **Sheet 1 of 2**

Date(s) Drilled **6/23/23**	Logged By **LB**	Checked By **NS**
Drilling Method **Hand Tools**	Drill Bit Size/Type **5"**	Total Depth of Borehole **10.5 feet**
Drill Rig Type **Hand Tools**	Drilling Contractor **Juan Garcia**	Approximate Surface Elevation **N/A**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **Modified California**	Hammer Data **N/A**
Borehole Backfill **Native**	Location **063003105 & 063003106, Landers**	

Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	REMARKS AND OTHER TESTS
0			SM		ALLUVIUM (Qa): SILTY SAND, fine-grained sand, loose, brown			
	■		SM		some gravel, damp, dense	5.4	103.7	
5	■		SP-SM		ALLUVIUM (Qa): SAND TO SILTY SAND, fine-grained sand, dry, medium dense, brown	1.7		
10	■		SM		ALLUVIUM (Qa): SILTY SAND, fine-grained sand, some gravel and very silty, damp, medium dense, brown	3.5	109.6	
15								

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Figure A-5

Project: **063003105 & 063003106**	NTS GEOTECHNICAL	Log of Boring B-3
Project Location: **063003105 & 063003106, Landers**		**Sheet 2 of 2**
Project Number: **23230**		

Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	REMARKS AND OTHER TESTS
15			SM		damp	3.1	106.2	
					Total Depth = 15.5 feet Groundwater not encountered Backfilled with native			
20								
25								
30								
35								
40								
45								
50								

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Figure A-5

Project: **063003105 & 063003106** Project Location: **063003105 & 063003106, Landers** Project Number: **23230**	NTS GEOTECHNICAL	# Log of Boring B-2 **Sheet 1 of 1**

Date(s) Drilled **6/23/23**	Logged By **LB**	Checked By **NS**
Drilling Method **Hand Tools**	Drill Bit Size/Type **5"**	Total Depth of Borehole **5.5 feet**
Drill Rig Type **Hand Tools**	Drilling Contractor **Juan Garcia**	Approximate Surface Elevation **N/A**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **Modified California**	Hammer Data **N/A**
Borehole Backfill **Native**	Location **063003105 & 063003106, Landers**	

Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	REMARKS AND OTHER TESTS
0			SM		ALLUVIUM (Qa): SILTY SAND, fine-grained sand, dry, loose, brown			
	■		SM		some gravel, dry, dense	1.7	109.7	
5	■		SM		dry	2.0	112.8	
					Total Depth = 5.5 feet Groundwater not encountered Backfilled with native			
10								
15								

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Figure A-4

Project: **063003105 & 063003106** Project Location: **063003105 & 063003106, Landers** Project Number: **23230**	NTS GEOTECHNICAL	# Log of Boring B-4 **Sheet 1 of 1**

Date(s) Drilled **6/23/23**	Logged By **LB**	Checked By **NS**
Drilling Method **Hand Tools**	Drill Bit Size/Type **5"**	Total Depth of Borehole **5.5 feet**
Drill Rig Type **Hand Tools**	Drilling Contractor **Juan Garcia**	Approximate Surface Elevation **N/A**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **Modified California**	Hammer Data **N/A**
Borehole Backfill **Native**	Location **063003105 & 063003106, Landers**	

Depth (feet)	Sample Type	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	REMARKS AND OTHER TESTS
0			SM		ALLUVIUM (Qa): SILTY SAND, fine-grained sand, some gravel, dry, loose, brown			
	■		SM		dry, dense	2.1	110.1	
5	■		SM		dry, medium dense	2.2	116.8	
					Total Depth = 5.5 feet Groundwater not encountered Backfilled with native			
10								
15								

C:\Users\info\NTS GEOTECHNICAL\Projects - General\2023\23230 - APN 063003105 & 063003106, Landers\Reports\SOILS\APPENDIX A\23230 Boring Log B-1 to B-5.bg4[NTS Template 1-9-21.tpl]

Figure A-6

APPENDIX B

Laboratory Testing Data

NTS GEOTECHNICAL

Appendix B
Geotechnical Laboratory Testing

Laboratory Moisture Content and Density Tests

The moisture content and dry densities of selected driven samples obtained from the exploratory boring was evaluated in general accordance with the latest version of ASTM D 2937. The test results are presented on the log of the exploratory boring in Appendix A.

Wash Sieve

The number of fines passing the No. 200 sieve was evaluated by the wash sieve. The test procedure was in general accordance with ASTM D 1140. The results are attached to this Appendix B.

Boring No.	Depth (ft)	Fines Passing No. 200, %
B-1	2	16.2
B-1	5	20.7
B-1	10	17.3
B-2	2	12.0
B-2	5	20.4
B-3	2	14.9
B-3	5	11.6
B-3	10	18.2
B-3	15	15.7
B-4	2	18.4
B-4	5	22.1
B-5	2	13.4
B-5	5	13.2
B-5	10	33.2

Gradation Test

The number of fines of a sample passing the No. 200 sieve was evaluated by assembling a group of sieves with a collecting pan at the bottom. The test procedure was in general accordance with ASTM D 6913. The results are attached to this Appendix B.

Direct Shear Tests

Direct shear tests were performed on selected remolded and relatively undisturbed soil samples in general accordance with ASTM D 3080 to evaluate the shear strength characteristics of the materials. The samples were inundated during shearing to represent adverse field conditions. Direct shear test results are attached to this Appendix B.

Consolidation Test

Consolidation tests was performed on a selected driven soil sample in general accordance with the latest version of ASTM D2435. The sample was inundated during testing to represent adverse field conditions. The percent consolidation for each load cycle was recorded as a ratio of the amount of vertical compression to the original height of the sample. Consolidation testing results are attached to this Appendix B.

Corrosion Suite

The corrosion potential of typical on-site materials under long-term contact with both metal and concrete was determined by chemical and electrical resistance tests. The soluble sulfate test for potential concrete corrosion was performed in general accordance with ASTM D4327. The test results are attached to this Appendix B.

GRADATION TEST RESULTS

Date Tested: 6/18/2023

USCS

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Boring No.	Sample No.	Depth (ft)	Passing 200 (%)	USCS Classification
P-1	Bulk	2'-4'	19.3	#NAME?

Sample Description	Brown #NAME?	Moisture Percent	1.1

	Sieve Size		% Passing
Sieve Analysis	2"	50 mm	100
	1.5"	37.5 mm	100
	1"	25 mm	100
	3/4"	19 mm	100
	1/2"	12.5 mm	100
	3/8"	9.5 mm	99
	No. 4	4.75 mm	89
	No. 10	2.0 mm	65
	No. 20	0.85 mm	48
	No. 40	0.425 mm	39
	No. 60	0.25 mm	29
	No 100	0.15 mm	25
	No 200	.075 mm	19.3

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 6913

NTS GEOTECHNICAL

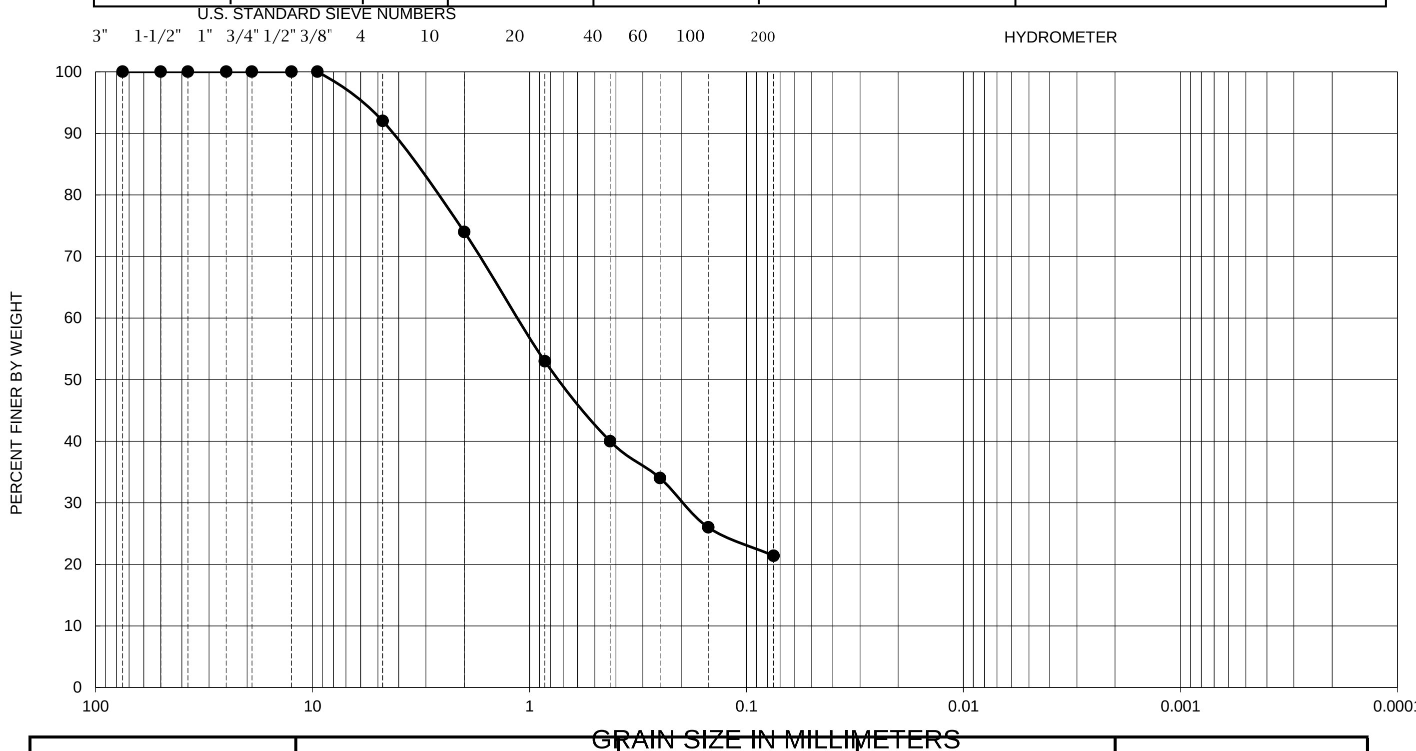
Project #	23230	Tech:	LB

Project Name	Figure
Belfield Blvd	**B-1**

GRADATION TEST RESULTS

Date Tested: 6/18/2023

USCS	GRAVEL		SAND			FINES	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay



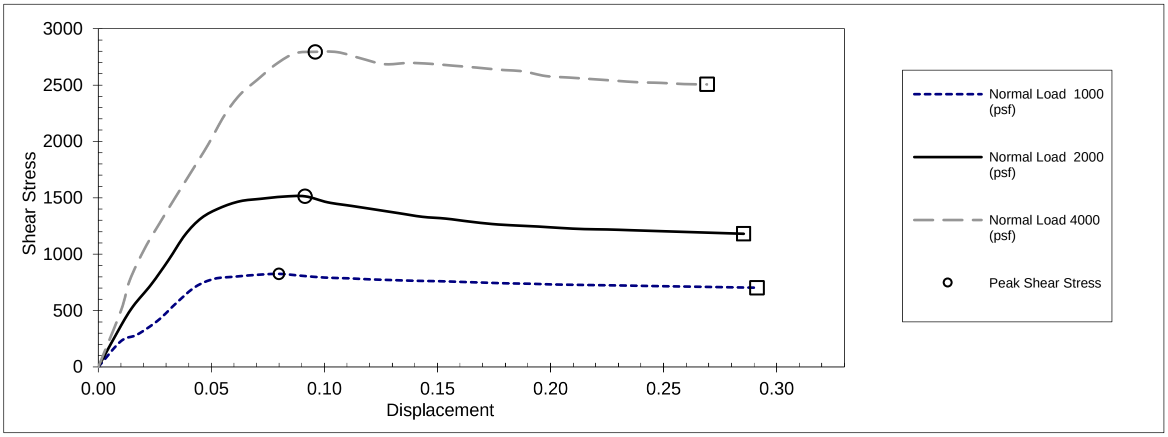
Boring No.	Sample No.	Depth (ft)	Passing 200 (%)	USCS Classification
P-4	Bulk	2'-4'	21.4	#NAME?

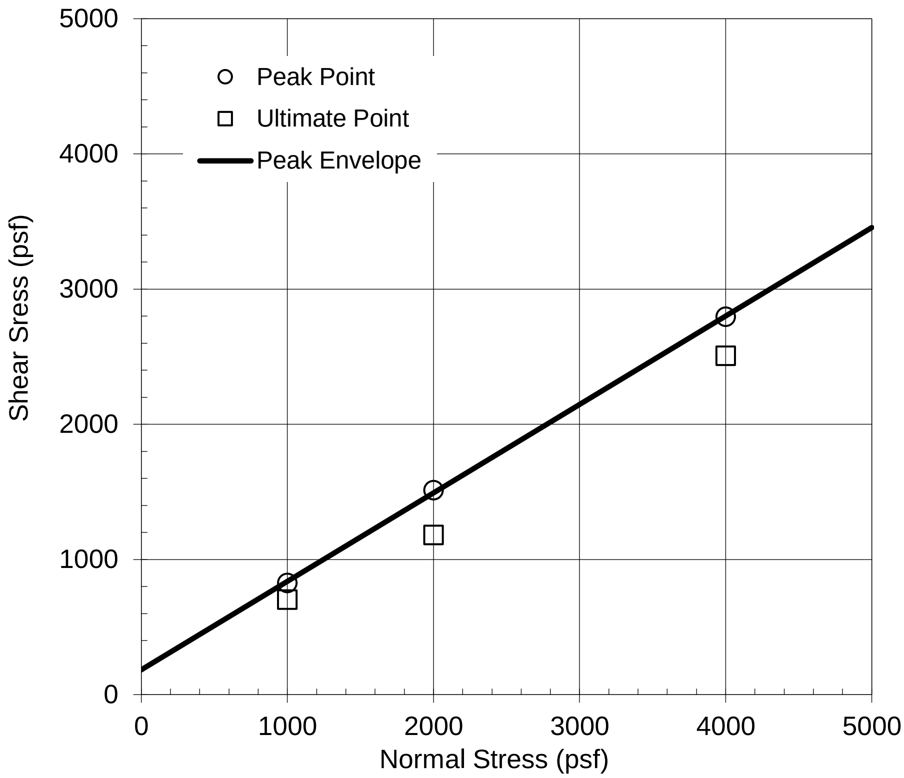
Sample Description	Brown #NAME?	Moisture Percent	1.6

	Sieve Size		% Passing
Sieve Analysis	2"	50 mm	100
	1.5"	37.5 mm	100
	1"	25 mm	100
	3/4"	19 mm	100
	1/2"	12.5 mm	100
	3/8"	9.5 mm	100
	No. 4	4.75 mm	92
	No. 10	2.0 mm	74
	No. 20	0.85 mm	53
	No. 40	0.425 mm	40
	No. 60	0.25 mm	34
	No 100	0.15 mm	26
	No 200	.075 mm	21.4

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 6913

NTS GEOTECHNICAL	Project Name	Figure
Project # 23230 Tech: LB	Belfield Blvd	B-2





Strain Rate =	0.0118	inch/min		Interpreted Shear Strength			
Date Tested:	6/24/2023			Peak		Ultimate	
Boring No.	Sample No.	Depth	UCSC	Cohesion (psf)	Friction Angle (deg)	Cohesion (psf)	Friction Angle (deg)
B-1	1	5	SM	184	33.2	40	31.4
Sample description:		Brown Silty Sand					

NTS GEOTECHNICAL		**Direct Shear Test Results**	Figure
	Tech: LB	**Belfield Blvd.**	**B-3**
Project # 23230	3-Jul-23		

Date Tested	6/23/2023			
Boring No.	B-2			
Depth, ft.	5			
Sample Description	Brown Silty Sand			
Soil Condition	Before	After		
Weight Wet Sample and Ring, g	177.5	195.0		
Weight Dry Sample and Ring	175.0	175.0		
Weight Ring, g	40.9	40.9		
Weight Dry Sample	134.1	134.1		
Moisture Content, %	1.9	14.9		
Wet Density, lbs/cu. ft.	113.1	128.4		
Dry Density, lbs/cu. ft.	111.1	111.8		
Void Ratio	0.49	0.48		
Saturation, %	10.1	82.4		
Consolidation Data				
Load, psf	1000	1000		
Initial Height, in.	1.0000			
Final Height, in.		0.9937		
Consolidation % of Sample Height	**0.6**			

NTS GEOTECHNICAL

Project # 23230 Tech L.B.

Consolidation Test

Belfield Blvd

FIGURE **B-4**

Date Tested	6/25/2023			
Boring No.	B-3			
Depth, ft.	10			
Sample Description	Brown Silty Sand			
Soil Condition	Before	After		
Weight Wet Sample and Ring, g	179.4	198.4		
Weight Dry Sample and Ring	175.1	175.1		
Weight Ring, g	41.1	41.1		
Weight Dry Sample	134.0	134.0		
Moisture Content, %	3.2	17.4		
Wet Density, lbs/cu. ft.	114.5	132.6		
Dry Density, lbs/cu. ft.	111.0	113.0		
Void Ratio	0.49	0.46		
Saturation, %	17.4	99.4		
Consolidation Data				
Load, psf	1000	1000		
Initial Height, in.	1.0000			
Final Height, in.		0.9823		
Consolidation % of Sample Height	**1.8**			

NTS GEOTECHNICAL

Project # 23230 Tech L.B.

Consolidation Test

Belfield Blvd

FIGURE

B-5

Soil Analysis Lab Results

Client: NTS Geotechnical
Job Name: Belfield Boulevard, Landers
Client Job Number: X
Project X Job Number: S230626C
June 27, 2023

	Method	ASTM D4327		ASTM D4327		ASTM G187		ASTM G51
Bore# / Description	**Depth**	**Sulfates** SO_4^{2-}		**Chlorides** Cl^-		**Resistivity** As Rec'd | Minimum		**pH**
	(ft)	(mg/kg)	(wt%)	(mg/kg)	(wt%)	(Ohm-cm)	(Ohm-cm)	
B-1 Brown silty sand	2-5	23.2	0.0023	12.3	0.0012	>737,000	14,070	7.3

Cations and Anions, except Sulfide and Bicarbonate, tested with Ion Chromatography
mg/kg = milligrams per kilogram (parts per million) of dry soil weight
ND = 0 = Not Detected | NT = Not Tested | Unk = Unknown
Chemical Analysis performed on 1:3 Soil-To-Water extract
PPM = mg/kg (soil) = mg/L (Liquid)

Note: Sometimes a bad sulfate hit is a contaminated spot. Typical fertilizers are Potassium chloride, ammonium sulfate or ammonium sulfate nitrate (ASN). So this is another reason why testing full corrosion series is good because we then have the data to see if those other ingredients are present meaning the soil sample is just fertilizer-contaminated soil. This can happen often when the soil samples collected are simply surface scoops which is why it's best to dig in a foot, throw away the top and test the deeper stuff. Dairy farms are also notorious for these items.

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APPENDIX C

PERCOLATION TESTING

NTS GEOTECHNICAL

Project Name:	Belfield Blvd	Depth to Bottom of Hole (ft):	4
Project #:	23230	Hole Diameter (in.)	6
Test Date:	6/23/2023	Tested By:	LB
Test Hole #:	P1	No Caving Observed	

Depth (feet)	Soil Classification
0'-4'	Brown Silty Sand (SM)

PRE-SOAK					
	Date	Gallons Used	Start Time	End Time	Water Remained In Hole (Y/N)
Pre-Soak Trial 1	23-Jun-23	5	5:35 AM	6:00 AM	N
Pre-Soak Trial 2	23-Jun-23	5	6:00 AM	6:25 AM	N

Initial Time	Final Time	Change in Time	Initial Depth (in.)	Final Depth (in.)	Change in Depth (in.)	Percolation Rate (min./inch)
6:25	6:30	10	12.0	9.00	3.00	3.33
6:30	6:40	10	12.0	9.00	3.00	3.33
6:40	6:50	10	12.0	9.25	2.75	3.64
6:50	7:00	10	12.0	9.50	2.50	4.00
7:00	7:10	10	12.0	9.75	2.25	4.44
7:10	7:20	10	12.0	10.00	2.00	5.00
					PERCOLATION RATE (MIN./INCH):	**5.00**

NTS GEOTECHNICAL

Project Name:	Belfield Blvd	Depth to Bottom of Hole (ft):	4
Project #:	23230	Hole Diameter (in.)	6
Test Date:	6/23/2023	Tested By:	LB
Test Hole #:	P2	No Caving Observed	

Depth (feet)	Soil Classification
0'-4'	Brown Silty Sand (SM)

PRE-SOAK					
	Date	Gallons Used	Start Time	End Time	Water Remained In Hole (Y/N)
Pre-Soak Trial 1	23-Jun-23	5	5:30 AM	5:55 AM	N
Pre-Soak Trial 2	23-Jun-23	5	5:55 AM	6:20 AM	N

Initial Time	Final Time	Change in Time	Initial Depth (in.)	Final Depth (in.)	Change in Depth (in.)	Percolation Rate (min./inch)
6:20	6:30	10	12.0	8.75	3.25	3.08
6:30	6:40	10	12.0	8.75	3.25	3.08
6:40	6:50	10	12.0	9.00	3.00	3.33
6:50	7:00	10	12.0	9.00	3.00	3.33
7:00	7:10	10	12.0	9.50	2.50	4.00
7:10	7:20	10	12.0	9.50	2.50	4.00
					PERCOLATION RATE (MIN./INCH):	**4.00**

NTS GEOTECHNICAL

Project Name:	Belfield Blvd	Depth to Bottom of Hole (ft):	5
Project #:	23230	Hole Diameter (in.)	6
Test Date:	6/23/2023	Tested By:	LB
Test Hole #:	P3	No Caving Observed	

Depth (feet)	Soil Classification
0'-6'	Brown Silty Sand (SM)

PRE-SOAK					
	Date	Gallons Used	Start Time	End Time	Water Remained In Hole (Y/N)
Pre-Soak Trial 1	23-Jun-23	5	5:00 AM	5:25 AM	N
Pre-Soak Trial 2	23-Jun-23	5	5:25 AM	5:50 AM	N

Initial Time	Final Time	Change in Time	Initial Depth (in.)	Final Depth (in.)	Change in Depth (in.)	Percolation Rate (min./inch)
5:50	6:00	10	12.0	9.00	3.00	3.33
6:00	6:10	10	12.0	9.00	3.00	3.33
6:10	6:20	10	12.0	9.50	2.50	4.00
6:20	6:30	10	12.0	9.50	2.50	4.00
6:30	6:40	10	12.0	9.75	2.25	4.44
6:40	6:50	10	12.0	9.75	2.25	4.44
					PERCOLATION RATE (MIN./INCH):	**4.44**

NTS GEOTECHNICAL

Project Name:	Belfield Blvd	**Depth to Bottom of Hole (ft):**	6
Project #:	23230	**Hole Diameter (in.)**	6
Test Date:	6/23/2023	**Tested By:**	LB
Test Hole #:	P4	No Caving Observed	

Depth (feet)	Soil Classification
0'-6'	Brown Silty Sand w/ Gravel (SM)

PRE-SOAK					
	Date	Gallons Used	Start Time	End Time	Water Remained In Hole (Y/N)
Pre-Soak Trial 1	23-Jun-23	5	5:40 AM	6:05 AM	N
Pre-Soak Trial 2	23-Jun-23	5	6:05 AM	6:30 AM	N

Initial Time	Final Time	Change in Time	Initial Depth (in.)	Final Depth (in.)	Change in Depth (in.)	Percolation Rate (min./inch)
6:30	6:40	10	12.0	9.25	2.75	3.64
6:40	6:50	10	12.0	9.25	2.75	3.64
6:50	7:00	10	12.0	9.50	2.50	4.00
7:00	7:10	10	12.0	9.50	2.50	4.00
7:10	7:20	10	12.0	9.75	2.25	4.44
7:20	7:30	10	12.0	10.00	2.00	5.00
					PERCOLATION RATE (MIN./INCH):	**5.00**

NTS GEOTECHNICAL

APPENDIX D

Leachline Caclulations

Project Name:	APN 063003105 & 063003106, Landers
Project #:	23230

Percolation Rate (min/inch)	Application Rate (sf/gallon/day)	Flow (gallons/day)	Design Rate (sf/100 gstc)
5	0.83	10000	55

Septic Tank Capacity (gallons)	Absorption Area Required (square feet)	Multi-Units Area Increase (30%)	Required Leach Line Length (3-Foot-Wide Trench)		
			1-Foot Rock	2-Foot Rock	3-Foot Rock
			Allowable Square Feet of Leaching Area per Foot of Leach Line		
			3	5	7
15000	8300	10790	3597	2158	1541

1-Foot of Rock		2-Feet of Rock		3-Feet of Rock	
No. of Lines	Length Per Line (ft.)	No. of Lines	Length Per Line (ft.)	No. of Lines	Length Per Line (ft.)
37	97	22	98	17	91
38	95	23	94	18	86

Additional Requirements:

Rock depths are below pipe.
Maximum Length of Single Leach Line: 100 feet
Maximum Spacing of 3-Foot Wide Trenches:

On Center Spacing (ft.)	Depth of Rock
7	1-Foot of Rock
9	2-Feet of Rock
11	3-Feet of Rock