



TO: Town of Oro Valley Development Services Dept.
Attn: Bayer Vella AICP, Planning Manager

PROJECT: Rancho Vistoso Parcel 5-R Proposed Rezoning
January 2026 Project Update and Hearing Request

FROM: Paul Oland

DATE: 1/23/2026

PROJECT #: 19avh01

Dear Mr. Vella,

On December 29th, 2021, between Christmas and New Year's Eve, the potable water line serving Pima County's wastewater lift station at the Valley Vista subdivision sprung a massive underground leak, dumping 84,750 gallons of water into the surrounding soil over a 14-hour period. Because of the depth underground of the leak and the lack of any active leak detection devices, the leak was not discovered quickly, and significant damage / subsidence resulted. Pima County repaired the leak, the homebuilder repaired the damage, and operations have resumed as normal.

On January 9th, 2023, we submitted our request to rezone Rancho Vistoso Parcel 5-R to allow the development of a single-family residential subdivision similar to, and compatible with, Valley Vista. Six months later the Planning & Zoning Commission recommended approval of the project. Around that time several homes in Valley Vista exhibited foundation cracks, and some of the public roadway infrastructure near the lift station also exhibited issues associated with soil settlement. Consequently, the Town requested that we have a geotechnical engineer conduct soils testing onsite to determine the feasibility of developing the proposed subdivision.

Ninyo & Moore analyzed existing geotechnical findings in the area, including within Valley Vista. Ninyo also performed soil borings to analyze the subsurface soil conditions within Vistoso 5-R. Their resulting report included construction recommendations to address the soil conditions found onsite. We then proceeded to Town Council for consideration of the rezoning request. Despite Ninyo's findings and recommendations the Town Council was understandably hesitant to approve additional development nearby Valley Vista. This project was continued until "further soils testing" was conducted, with caveat that assumed a clear soils boundary would be found: "no homes, roads, or buildings" were to be built on "the layer of soil that is known to be prone to subsidence with moisture exposure". Such a broad and sweeping restriction was understandable due to the fact that the specific cause and extent of the impact of the Valley Vista water leak was still being investigated.

Since then, several important findings have come to light:

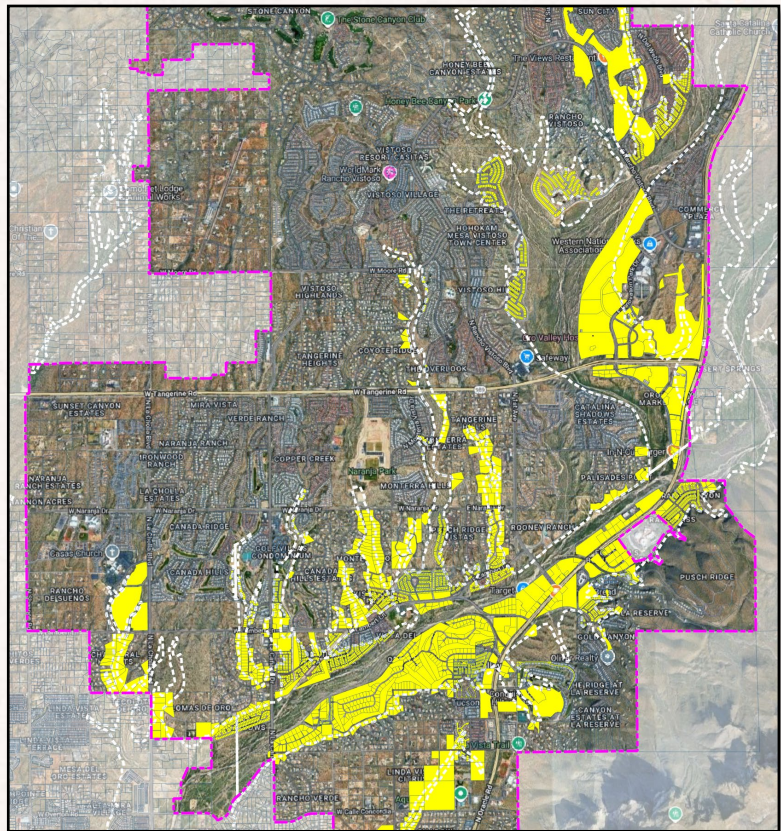
- The water line that broke is owned and maintained by Pima County, not Oro Valley. No such water line nor any lift station will be installed or constructed within Vistoso 5-R.
- When the leak occurred Pima County did not respond to OVWU's automated leak alerts.
- Had Pima County addressed the leak immediately, the eventual soil settlement likely would have been able to be minimized by immediate pumping of the area.
- The water line that broke is not part of Oro Valley's water system.
- The damage has been mitigated by the homebuilder despite the fact that the County's water line caused the problem.

As required by the Town Council's 2023 continuance requirement, we commissioned Ninyo & Moore conduct further soil studies within Vistoso 5-R. Ninyo determined that the soil characteristics are fairly uniform across the site and surrounding areas, including Valley Vista. Indeed, roughly 19% of the Town as a whole has similar soil to Valley Vista. Ninyo issued an updated report with refined construction recommendations to further mitigate the concern about future soil settlement.

We respectfully request Town Council's well-intentioned 2023 continuance requirement regarding placement of improvements over the soil type in question be waived for the following reasons:

- We have conducted the required additional soils testing and now have refined recommendations from Ninyo & Moore to address the concern about soil settlement.
- Vistoso 5-R will not have a wastewater lift station or County-owned water line and thus will not have the circumstances that led to the Valley Vista leak. In fact, the entire water system up to each home's meter within Vistoso 5-R will be owned, maintained, and monitored by the Oro Valley Water Utility.
- HDPE piping will be used in Vistoso 5-R's water system. HDPE is widely used as a more durable alternative to PVC in municipal and mining water systems, and has an industry-recognized useful life of over a century.
- Thousands of homes and businesses in Oro Valley have existed over this type of soil for decades, without significant problems. Notable businesses, institutions, and neighborhoods include the Oro Valley Hospital, Honeywell, Oro Valley Marketplace, Steam Pump Ranch, Basis School, the Rooney Ranch Shopping Center, San Dorado, Securaplane, the Oro Valley Country Club, Tranquillo, Alterra, portions of the Villages of La Canada and La reserve, and others.

**Properties in Oro Valley
With Soils Similar to
Vistoso 5-R & Valley Vista:**



- Zooming out, tens of thousands of homes and businesses in the greater Tucson metropolitan area have existed over this type of soil for decades, without significant problems. Notable businesses, institutions, and neighborhoods include the Arizona Supreme Court building, the US District Courthouse, Tucson Fire District headquarters, Caterpillar regional headquarters, Pima County jail, the FBI building, Tucson Mall, the Tucson Jewish Community Center, Tucson Country Club, Pima Community College, Costco, Lowes, Target, Home Depot, and several elementary and middle schools.



To address the Town Council's 2023 hesitation about allowing development of Vistoso 5-R, the developer proposes the following additional commitments:

- All water system connections (homes, common area landscaping, etc.) shall be fitted with a FloLogic Leak Detection & Water Auto-Shutoff System with Connect Module or approved equal.
- To ensure compatibility with the Valley Vista subdivision, all homes within 100 feet of the northern property boundary shall be limited to single-story.
- The developer shall adhere to the findings of the May 2025 geotechnical evaluation by Ninyo & Moore (See Sections 11 & 12, attached), which includes construction recommendations designed to address the concerns about potential subsidence, rendering the development of the proposed neighborhood feasible from a geotechnical standpoint. Please see the attached letter from Ninyo & Moore dated May 20, 2025, which acknowledges the saturation characteristics of the soil and provides recommendations for building improvements on the soil. Ninyo did not conclude that it was unwise, uncommon or unreasonable to build improvements on the soil contained in Parcel 5-R, but instead detailed a process with which to proceed. Below are some highlights from Ninyo's recommendations:
 - Permanent slopes shall be 3:1 or flatter. Embankments shall be over-excavated up to 5', and recompacted.
 - Fill soils not suitable for re-use as engineered fill shall be re-used in non-structural areas (landscaping).
 - For structures, engineered fill shall extend 3' to 10' below grade, depending on the type of foundation used. Heavier-loaded structures shall have engineered fill extending deeper depending on structural calculations.
 - For wet utility lines, engineered fill shall extend 5' to 7' below the pipe bedding unless partially mitigated by installation of a geogrid layer.
 - Prior to recompaction of over-excavated areas, the geotechnical engineer shall inspect such areas to confirm removal or mitigation of soft, loose, or wet soils.
 - Roof drains shall be directed away from structures to a stormdrain or other location providing positive drainage at least 5' away from the structure.

We appreciate the opportunity to bring this P&Z-endorsed neighborhood back to Town Council for consideration. Please do not hesitate to contact me with any questions, suggestions, or additional requests.

Sincerely,

A handwritten signature in black ink, appearing to read "Paul Oland". Below the signature, the name "Paul Oland" is printed in a small, black, sans-serif font.

Paul Oland

May 20, 2025
Project No. 607834001

Vistoso Partners, LLC
7117 East Rancho Vista Drive, Suite 6003
Scottsdale, Arizona 85251

Subject: Rancho Vistoso Parcel 5-R
 Oro Valley, Arizona

Dear Vistoso Partners, LLC:

We have issued our revised Preliminary Geotechnical Evaluation dated May 13, 2025 regarding the above referenced property. We understand that you are planning to develop the site for single family detached housing. While our Evaluation was prepared for you, we understand that you intend to share it with the Town of Oro Valley Town Council and staff for their review and approval.

As our report indicates, the soils on the property consist of variable densities, some of which exhibit collapse potential and increased compressibility upon inundation and high degrees of saturation. These soil types have been encountered in existing housing developments in Oro Valley and the greater Tucson region. We believe that from a geotechnical perspective it is feasible to construct single family houses on the property, provided that the site preparation and construction recommendations contained in Section 11 of our May 13, 2025 report are followed. We are mindful of the Oro Valley Town Council's concern that "no homes, roads, or buildings shall be built on the layer of soil that is known to be prone to subsidence with moisture exposure". Knowing this, we have recommended in Section 11.1.2 of our May 13 2025 report that such layers of soil which are generally classified as "loose to very dense silty sand, well graded sand with silt, and clayey sand" be improved to address the concerns about potential subsidence.

We understand that other projects in close proximity to Parcel 5-R have been evaluated and comparable soils reports have been prepared. We also understand that development projects on these parcels have been previously reviewed and approved by the Town of Oro Valley and that many of these parcels are located in a similar geologic setting as Parcel 5-R.

It is our understanding that Parcel R-5 is planned for a typical single-family subdivision and that no lift station or other similar improvements for the property are planned.

A detailed geotechnical study should be conducted during the final design stage of the above referenced project and prior to final construction to better evaluate the subsurface conditions within the project site and to develop final subgrade improvement recommendations.

Nothing in this letter is intended to modify the contents of our Preliminary Geotechnical Evaluation dated May 13, 2025 or to alter the limitations contained in Section 13 of the Evaluation.

Respectfully submitted,
NINYO & MOORE, A SOCOTEC COMPANY



Fred F. Narcaroti
Principal, Safford/Tucson Office Manager

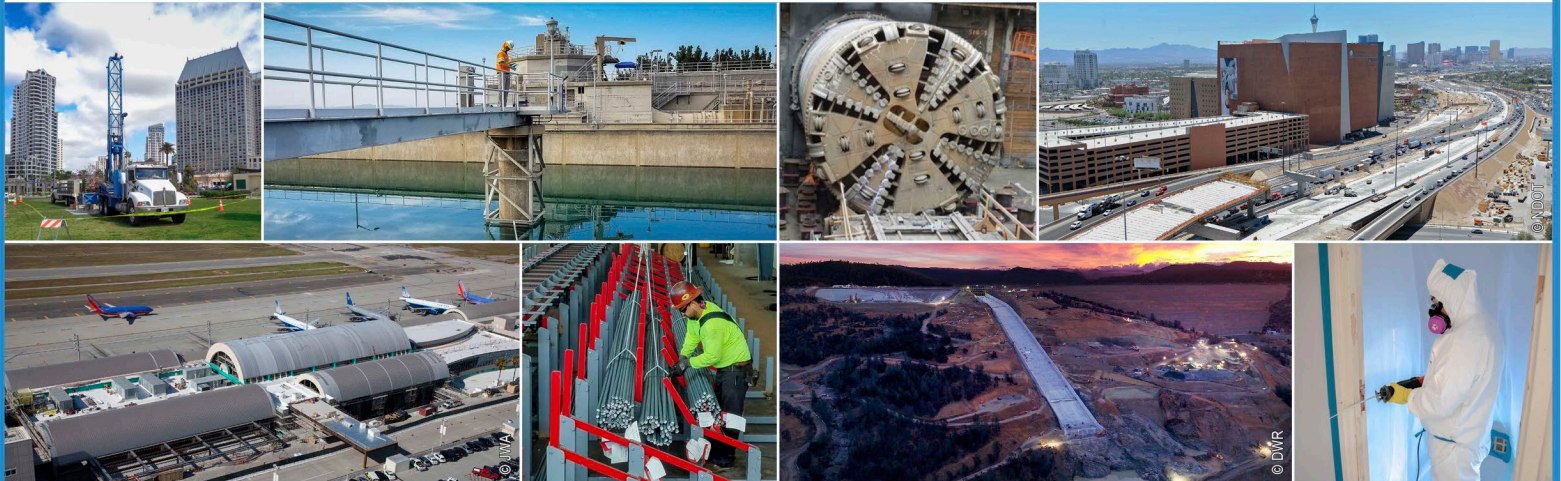
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Preliminary Geotechnical Evaluation Rancho Vistoso Parcel 5-R Planned Area Development Amendment Oro Valley, Arizona

Vistoso Partners, LLC

7117 East Rancho Vista Drive, Suite 6003 | Scottsdale, Arizona 85251

May 13, 2025 | Project No. 607834001



Geotechnical | Environmental | Construction Inspection & Testing | Forensic Engineering & Expert Witness

Geophysics | Engineering Geology | Laboratory Testing | Industrial Hygiene | Occupational Safety | Air Quality | GIS

Ninyo & Moore
Geotechnical & Environmental Sciences Consultants

Preliminary Geotechnical Evaluation Rancho Vistoso Parcel 5-R Planned Area Development Amendment Oro Valley, Arizona

Mr. Mark Winkleman
Vistoso Partners, LLC
7117 East Rancho Vista Drive, Suite 6003 | Scottsdale, Arizona 85251

May 13, 2025 | Project No. 607834001



Marek J. Kasztalski, PE
Principal Engineer

MJK/SDN/FFN/amg



Fred F. Narcaroti
Principal, Safford/Tucson Office Manager



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1 INTRODUCTION

In accordance with our proposals dated July 28, 2023, and January 14, 2025, and your authorization, we have performed a preliminary geotechnical evaluation for the design and construction of Rancho Vistoso Parcel 5-R Planned Area Development (PAD) Amendment in Oro Valley, Arizona (Figure 1). The purpose of our evaluation was to assess the subsurface conditions at the project site in order to provide preliminary geotechnical recommendations for design and construction.

We first mobilized to the site on August 24 and 25, 2023 and prepared a preliminary geotechnical report dated September 6, 2023. That initial exploration primarily covered the norther and eastern portion of the proposed development area. Through follow up discussions with the project stakeholders, Ninyo & Moore was requested to conduct an additional evaluation within the western and southern portions of the site. This additional work was performed earlier this year.

This updated report presents the results of our initial (2023) and current (2025) evaluations and our preliminary geotechnical conclusions and recommendations regarding the proposed construction.

A supplemental geotechnical study that will include additional soil borings, laboratory testing and analysis should be conducted for the project final design phase.

2 SCOPE OF SERVICES

The scope of our services for this phase of the project generally included:

- Reviewing available topographic information, soil surveys, geologic literature, historic geotechnical data, and aerial photographs of the project area.
- Conducting a visual reconnaissance of the project area and marking out the boring locations.
- Notifying Arizona 811 of the proposed exploration locations prior to conducting our field work.
- Drilling, logging, and sampling 10 exploratory soil borings to approximate depths of 34 to 50 feet below ground surface (bgs). The boring logs are presented in Appendix A.

- Performing laboratory tests on selected samples collected from our borings to evaluate the in-situ moisture content and dry density, gradation, Atterberg limits, consolidation, and corrosivity characteristics (including pH, minimum electrical resistivity, and soluble sulfate and chloride contents). The results of the laboratory tests are included in Appendix B.
- Preparing this report presenting our findings, conclusions, and preliminary recommendations regarding the proposed design and construction.

Our scope of services did not include environmental consulting services such as hazardous waste sampling or analytical testing at the site. A detailed scope of services and estimated fee for such services can be provided upon request.

3 SITE DESCRIPTION

The project site, Parcel 5-R, is located within the southeastern and currently undeveloped parcel just south of Rancho Vistoso Valley Vista development, south in Moore Loop and Kalalau Drive, in Oro Valley, Arizona.

At the time of our evaluation, the project site was undeveloped land with sparse to dense desert vegetation with trails and paths, and small washes traversing the site in a generally west to east direction. The recently developed adjacent portion of the development, including residential properties and a Pima County pump station, is situated near the western flank of Honey Bee Canyon, just north of the project site. The easterly portion of Parcel 5-R is located within the Big Wash floodplain.

4 TOPOGRAPHIC MAP AND AERIAL PHOTOGRAPH REVIEW

According to the Oro Valley, Pima County, 7.5-Minute United States Geological Survey Topographic Quadrangle Map (2021) the average site elevation is approximately 2,720 feet relative to mean sea level (MSL). The topography of the site is relatively flat and slopes gently from west to east.

Several historical aerial photographs from Google Earth™ were reviewed for this project. Images dated 1992 through 2018 depicted the project area as undeveloped land with relatively dense vegetation. The Honey Bee Canyon with the Big Wash were located to the east of the site. Unpaved paths and trails were observed on the images from the late 1990's and later. Small drainages and washes traversed the site generally trending from northwest to southeast. An image dated December 2020 depicted the roadways of the Valley Vista residential subdivision and the pump station in place. By 2020, many of the building pads were prepared with few houses already built. Also, the FEMA floodplain bank protection system with soil-cement paved embankments was already constructed along the eastern and southeastern

edges of the subdivision, just north of the project site. However, Parcel 5-R remained undeveloped during that time. An image dated April 2024 depicted the project site and adjacent areas as being similar to its current condition.

5 REVIEW OF HISTORIC GEOTECHNICAL REPORTS

We have reviewed the following existing geotechnical reports related to the Valley Vista development:

- ProTeX, 2018, Geotechnical Investigation, Rancho Vistoso Neighborhood 5 – Parcel X and W, Rancho Vistoso Boulevard and Moore Loop, Oro Valley, Arizona.
- ProTeX, 2022, Geotechnical Investigation – Forensics, Rancho Vistoso Valley vista – Lot 19, 780 East Kalalau Drive, Oro Valley, Arizona: dated November 3, 2022.
- Ninyo & Moore, 2023, Geotechnical Services, Valley Vista Subdivision Soil Evaluation, Oro Valley, Arizona: dated August 17.
- Ninyo & Moore, 2023, Geotechnical Services, Valley Vista Sewer and Pump Station Evaluation, Oro Valley, Arizona: dated August 22.

5.1 ProTeX Geotechnical Investigation Report (2018)

In 2018, ProTeX conducted a geotechnical exploration within the area generally west and north of the project site in support of the then proposed Rancho Vistoso Valley Vista residential subdivision development. A total of 10 borings (B1 to B10) were drilled to a depth of 15 feet bgs for the purpose of evaluating subsurface conditions. Standard Penetration Tests (SPT) were performed in selected borings and at selected depths, where bulk and relatively undisturbed ring samples were also collected. The laboratory testing program included gradation, Atterberg limits, expansion index, R-value and chlorides and sulfates content.

Based on the field exploration and laboratory testing the subsurface profile consisted primarily of native alluvial sediments including silty sands, sandy silts and clayey sands with plasticity index ranging from 0 (non-plastic) to 12. Based on the field blow count testing (SPT N-values), ProTeX concluded that the subsurface soils were loose to medium dense and susceptible to hydro-collapse. These conditions were encountered in many areas of the site. ProTeX further indicated that the potential for hydro-consolidation of the subsurface soils should be mitigated. It was recommended that “due to light to moderate vegetation and loose/soft surface conditions, the surface soils should be over-excavated a minimum depth of 1.0 foot below existing grade or 1.0 foot below finished pad grade elevation, whichever is deeper. After clearing and over-excavation, the exposed soils should be scarified a minimum of eight inches, moisture

conditioned and compacted.” This overexcavation recommendation was applicable to the building foundation pads.

The report provided compaction specifications for subgrade below post-tension and conventional foundations as evaluated based on the standard Proctor test (ASTM D698), as summarized below:

- Below conventional interior floors: 95 percent;
- Below conventional foundation level and post-tension slab-on-grade: 95 percent;
- Fills at depths 5 to 10 feet below finish grade: 98 percent; and
- Fills at depths 10 feet or greater below finish grade: 100 percent.

5.2 ProTeX, 2022, Geotechnical Investigation – Forensics

ProTeX, conducted a forensic geotechnical investigation to evaluate the cause(s) of distress observed at residence Lot 19. The common area with the Pima County Pump Station located to the east of Lot 19 was also evaluated. A total of 23 borings were advanced to depth ranging between 25 and 71 feet bgs. The laboratory testing included index tests as well as consolidation (hydro-collapse potential). The field test results and observations indicated that the subsurface soils were very loose/soft with varying levels of moisture content with very damp to wet soils near the saturation level observed to substantial depths. Cracks in the roadway pavements and in the common area adjacent to the pump station were also observed.

In conclusions, ProTeX stated that the site soils are susceptible to progressive settlements and progressive displacement resulting in significant loss of soil support under certain foundation elements for the houses and site walls as well as underground utilities.

The recommendations included the following mitigation measures:

- Helical piers installed to competent material depths under foundations.
- Grouting compaction of subsurface soils around the houses and the pump station.
- Drainage evaluation to provide positive drainage away from foundation elements.

The depth of the above mitigation techniques was not defined and left to the remediation contractor/structural engineer judgement.

5.3 Ninyo & Moore, 2023A

In 2023, Ninyo & Moore conducted a geotechnical exploration within the easternmost portion of the Rancho Vistoso Valley Vista residential subdivision that encompassed southeastern segments of Kalalau Drive and Romsdalen Road. Ninyo & Moore cored the existing pavement at four locations along the roadway segments using an electronic coring machine and drilled four exploratory borings, through the aforementioned core holes to approximate depths of 3 and 20 feet bgs using hand auger techniques, and a truck mounted drill rig equipped with hollow stem augers. The laboratory testing included in-place moisture and dry density, gradation, Atterberg limits, consolidation, and laboratory maximum dry density.

The results of the study indicated relatively consistent subsurface conditions along both project alignments with silty sand and silty clayey sand soils encountered. The native alluvial soils were generally more compressible under loading and/or saturation and were in a relatively loose condition.

5.4 Ninyo & Moore, 2023B

In 2023, Ninyo & Moore conducted a geotechnical exploration the Rancho Vistoso Valley Vista residential subdivision within the area of the existing pump station southeast of Kalalau Drive and Romsdalen Road intersection. Ninyo & Moore drilled, logged, and sampled three exploratory borings to approximate depths of 20 to 65 feet bgs using a truck mounted drill rig equipped with hollow-stem augers (HSAs). Bulk and relatively undisturbed soil samples were collected at selected depth intervals in our borings. The laboratory testing included in-place moisture and dry density, gradation, Atterberg limits, consolidation, and laboratory maximum dry density.

The results of the study indicated relatively consistent subsurface conditions along both project alignments with silty sand and silty clayey sand soils encountered. The native alluvial soils were generally more compressible under loading and/or saturation and were in a relatively loose condition. The following were the findings of the study:

- The native alluvial soils exhibited relative densities that were generally lower than those for the fill material, especially at depths ranging between 10 and 25 feet bgs.
- The in-situ moisture contents and degrees of saturation were generally higher in the borings located closer to the pump station to approximate depths of 20 to 25 feet bgs.
- The collapse potential and compressibility measured from samples collected within the alluvial deposits were severe and significantly higher than for the fill material.

5.5 Summary of Historic Geotechnical Report Review

Based on the review of the above reports, the native alluvial deposits in the study areas are associated with the Big Wash floodplain and consist of layers of non-plastic silty sand, sand with silt, and low plasticity clayey sand with variable percentages of gravel. Many of these soils are in relatively loose condition and exhibit moderate to severe hydro-collapse potential and elevated compressibility upon saturation.

The saturation at Valley Vista is believed by the Town of Oro Valley to have resulted from a leak in a Pima County waterline serving the lift station. Per the project development team, no lift station is planned for the 5 R Parcel property.

6 PROPOSED CONSTRUCTION

We understand that Vistoso Partner, LLC (VP) is in the process of rezoning with the Town of Oro Valley (Town) for the site known as Rancho Vistoso Parcel 5-R PAD Amendment, that is located south of the Rancho Vistoso Valley Vista development in Oro Valley, Arizona. Ground settlements resulting in property damage haven recently been reported within the southeast portion of the recently developed Valley Vista Subdivision. Consequently, the Town has requested VP to conduct a third-party soil study to preliminarily evaluate the feasibility to development on this site.

Engineering plans for the future project were not available for our review. However, we assume that the new structures will be supported by shallow foundations and slabs on grade. We further assume that the new construction will involve moderate earthwork grading.

7 FIELD EXPLORATION AND LABORATORY TESTING

On August 24 and 25, 2023, and January 27, 2025, Ninyo & Moore conducted a subsurface exploration at the site in order to evaluate the subsurface conditions and to collect soil samples for laboratory testing. Our evaluation consisted of drilling, logging, and sampling of 10 exploratory borings using a CME 75 truck mounted drill rig equipped with HSAs (Figure 2). The borings extended to approximate depths of 34 to 50 feet bgs. Bulk and relatively undisturbed soil samples were collected at selected depth intervals in our borings.

Ninyo & Moore personnel logged the borings in general accordance with the Unified Soil Classification System and ASTM International (ASTM) test method D2488 by observing cuttings and drive samples. Collected ring samples were trimmed in the field, wrapped in plastic bags, and placed in cylindrical plastic containers to retain in-place moisture conditions. Similarly, SPT

and bulk samples were sealed in plastic bags to retain their approximate in-place moisture. Detailed descriptions of the soils encountered are presented on the boring log in Appendix A.

The soil samples collected from our exploratory activities were transported to the Ninyo & Moore laboratory in Tucson, Arizona for geotechnical laboratory testing. The testing included in-situ moisture content and dry density, gradation, Atterberg limits, consolidation, and corrosivity characteristics (including pH, minimum electrical resistivity, and soluble sulfate and chloride contents). The results of the in-situ moisture content and dry density testing are presented on the boring logs in Appendix A and a description of each laboratory test method and the remainder of the test results is presented in Appendix B.

8 GEOLOGY AND SUBSURFACE CONDITIONS

The project site is located in the Sonoran Desert Section of the Basin and Range physiographic province, which is typified by broad alluvial valleys separated by steep, discontinuous, subparallel mountain ranges. The mountain ranges generally trend north-south and northwest-southeast. The basin floors consist of alluvium with thickness extending to several thousands of feet.

The basins and surrounding mountains were formed approximately 18 million years ago during the mid- to late-Tertiary age. Extensional tectonics resulted in the formation of horsts (mountains) and grabens (basins) with vertical displacement along high-angle normal faults. Intermittent volcanic activity also occurred during this time. The surrounding basins were filled with alluvium from the erosion of the surrounding mountains as well as from deposition from rivers. Coarser-grained alluvial material was deposited at the margins of the basins near the mountains.

The surficial geology of the site is described as being Holocene age (10,000 years or less) basin-fill deposits composed of active stream channels, low stream terraces, and relatively un-dissected alluvial fans (Pearthree, 1998).

According to the United States Department of Agriculture, Natural Resource Conservation Service (NRCS) online Web Soil Survey, the proposed alignment crosses areas of two main soil types as described in Table 1 below.

Table 1 – NRCS Soil Units	
Soil Map Unit Name	Description of Soil Units
Anthony fine sandy loam	Fine sandy loam, stratified loamy sand to very fine sandy loam, gravelly loamy sand, and gravelly loamy coarse sand.
Pinaleno-Stagecoach-Palos Verdes	Very cobbly sandy loam, extremely cobbly sandy clay loam, extremely gravelly sandy clay loam.
Note: Loam is an agricultural soil classification that refers to a soil comprised of a mixture of clay, silt, and sand.	

8.1 Subsurface Conditions

The boring logs contain our field and laboratory test results, as well as our interpretation of conditions believed to exist between actual samples retrieved. Therefore, these boring logs contain both factual and interpretive information. Lines delineating subsurface strata on the boring logs are intended to group soils having similar engineering properties and characteristics. They should be considered approximate, as the actual transition between soil types (strata) may be gradual. Detailed stratigraphic information and a key to the soil symbols and terms used on the boring logs are provided in Appendix A.

Native alluvial soil deposits primarily associated with the Big Wash floodplain and low terrace were encountered at the surface of our borings and extended to the boring termination depths. The alluvium in our borings consisted of loose to very dense silty sand, poorly and well-graded sand with silt, poorly graded sand with clay, silty clayey sand and clayey sand with variable percentages of gravel. The soil relative densities measured by the SPT blow counts were generally increasing with depth. The general stratigraphy in terms of relative density is presented below:

- 0 to 10 feet: loose to medium dense condition;
- 10 to 25 feet: medium dense to dense condition; and
- Below 25 feet: dense to very dense condition.

However, relatively low densities as evaluated by SPT blow counts with medium dense condition extending to approximately 35 feet bgs were encountered in borings B-4 and B-8.

8.2 Groundwater

Groundwater was not encountered in our exploratory boring. Based on well data provided by the Arizona Department of Water Resources (ADWR), groundwater has been historically measured at a depth on the order of 110 feet bgs. However, it should be noted that groundwater levels

near the site can fluctuate due to seasonal variations, flows in the Big Wash, irrigation, groundwater withdrawal or injection, and other factors.

9 GEOLOGIC HAZARDS

The following section provides a discussion regarding potential geologic hazards such as land subsidence, earth fissures, faulting and seismicity.

9.1 Land Subsidence and Earth Fissures

Groundwater depletion, due to groundwater pumping, has caused land subsidence and earth fissures in numerous alluvial basins in Arizona. It has been estimated that subsidence has affected more than 3,000 square miles and has caused damage to a variety of engineered structures and agricultural land. From 1948 to 1983, excessive groundwater withdrawal has been documented in several alluvial valleys where groundwater levels have been reportedly lowered by up to about 500 feet. With such large depletions of groundwater, the alluvium has undergone consolidation resulting in large areas of land subsidence (Schumann and Genualdi, 1986).

In Arizona, earth fissures are generally associated with land subsidence and pose an on-going geologic hazard. Earth fissures generally form near the margins of geomorphic basins where significant amounts of groundwater depletion have occurred. Reportedly, earth fissures have also formed due to tensional stress caused by differential subsidence of the unconsolidated alluvial materials over buried bedrock ridges and irregular bedrock surfaces (Schumann and Genualdi, 1986).

Based on our field reconnaissance and review of the referenced material, there are no known earth fissures at the surface of the subject site. Based on fissure maps published by the Arizona Geological Survey (AZGS), the closest reported unconfirmed earth fissures to the site are located approximately 16.5 miles to the west of the project site near the Town of Marana (Shipman, 2007).

Continued groundwater withdrawal in the area may result in subsidence and the formation of new fissures or the extension of existing fissures. While the future occurrence of land subsidence and earth fissures cannot accurately be predicted, these phenomena are not expected to be a constraint to the construction of this project.

9.2 Faulting and Seismicity

The site lies within the Sonoran zone, which is a relatively stable tectonic region located in southwestern Arizona, southeastern California, southern Nevada, and northern Mexico (Euge et al., 1992). This zone is characterized by sparse seismicity and few Quaternary faults. Based on our field observations and on our review of readily available published geologic maps and literature, there are no known active faults underlying the subject site or adjacent areas.

The closest known Quaternary fault to the site is the Santa Rita Fault Zone, located approximately 33.5 miles southeast of the site. The Santa Rita Fault Zone is situated along the western piedmont of the Santa Rita Mountains. The fault zone is a series of northeast-striking normal faults that dip to the northwest. The most recent movement along this fault was approximately 130,000 years ago during the Middle to Late Pleistocene epoch. The slip-rate category of this fault is less than 0.2 millimeters per year (Pearthree, 1998). Seismic parameters recommended for the design of the proposed improvements are presented in Section 10.2.

10 CONCLUSIONS

Based on the results of our subsurface evaluation, laboratory testing, and data analysis, the proposed construction of houses and related improvements is feasible from a geotechnical standpoint, provided the recommendations of this report are incorporated into the design of the project, as appropriate. Geotechnical considerations include the following:

- The site soils can generally be excavated or ripped using heavy-duty earthmoving or excavation equipment. However, zones of very dense, gravelly/cobbly materials should be anticipated, which may result in difficult and/or slower excavation rates.
- Soils of variable relative densities encountered in our borings exhibit significant collapse potential and increased compressibility upon saturation. Our site preparation and construction recommendations contained in Section 11 below have been prepared to mitigate potential adverse impacts of these characteristics.
- Imported soils and soils generated from on-site excavation activities, that exhibit a relatively low plasticity index (PI) can generally be used for engineered fill. Based on the results of our study, many of the on-site soils are suitable for re-use as engineered fill.
- Groundwater was not observed in our borings. Based on ADWR well data, the regional groundwater table has been historically measured at depths on the order of 110 feet bgs. In general, groundwater is not expected to be a constraint to the design and construction of this project.
- No documented geologic hazards are present underlying or immediately adjacent to the site.
- Similar soil characteristics were observed in our borings and in our opinion may exist in many areas of the 5 R development.

11 PRELIMINARY RECOMMENDATIONS

The following sections present our preliminary geotechnical recommendations for the project design and construction. If the proposed construction is changed from that discussed in this report, Ninyo & Moore should be contacted for additional recommendations. A supplemental geotechnical study that will include additional soil borings, laboratory testing and analysis should be conducted for the project final design phase.

11.1 Earthwork

The following sections provide our earthwork recommendations for this project. In general, the earthwork specifications contained in the *Pima Association of Governments (PAG) Standard Specifications for Public Improvements (Standard Specifications)* are expected to apply unless specifically noted.

11.1.1 Site Preparation

Construction areas should be cleared of deleterious materials, if any are present, construction debris, vegetation, and any other material that might interfere with the performance or progress of the work. These materials should be disposed of at a legal dumpsite. Existing features that call for relocation or removal and extend below finished grade, if present, should be removed, and the resulting excavations backfilled with compacted engineered fill as discussed in this report.

11.1.2 Excavations

Our evaluation of the excavation characteristics of the on-site soils is based on the results of our exploratory borings, site observations, and experience with similar soils. The on-site soils include loose to very dense silty sand, well-graded sand with silt, and clayey sand which can generally be excavated or ripped using heavy-duty earthmoving or excavation equipment. However, very dense deposits of gravel and cobbles associated with the wash, although not observed in our borings, should also be anticipated, which could be more difficult to excavate and could slow the excavation rate.

Equipment and procedures should be used that do not cause significant disturbance to the excavation bottoms. Excavators and backhoes with buckets having large claws to loosen the soil should be avoided when excavating the last 6 to 12 inches. Such equipment will probably disturb the excavation bases. If wet or saturated soils are found at the excavation bases, these soils may soften under the action of light equipment and foot traffic. If the subgrade becomes disturbed, it should be compacted before placing the backfill material.

11.1.3 Temporary Slopes

Sidewalls for temporary excavations should not be anticipated to stand near-vertical without sloughing. Therefore, the contractor should provide safely sloped excavations or an adequately constructed and braced shoring system, in compliance with Occupational Safety and Health Administration (OSHA) regulations, for employees working in an excavation that may expose them to the danger of moving ground. For planning purposes and according to OSHA soil classifications, a "Type C" soil should be considered for this project. This corresponds to a temporary slope inclination no steeper than 1.5:1 (horizontal to vertical [H:V]) up to a height of 20 feet. During excavation, soil classification and excavation performance should be evaluated in the field by Ninyo & Moore in accordance with the OSHA regulations.

11.1.4 Permanent Slopes

A formal slope stability analysis was beyond the scope of this study; however, based on the subsurface conditions at the site we recommend that any permanent slopes have an inclination of 3:1 (Horizontal:Vertical), or flatter.

Exposed cut slopes may call for periodic maintenance due to sloughing and erosion. To reduce this potential for erosion, we recommend that erosion mitigation measures be placed on slopes. The establishment of long-term erosion mitigation measures is beneficial for aesthetics, reduces erosion by slowing runoff velocities, and protects soil from rainfall impact. Temporary measures may include, but not limited to, straw mulching or matting, and/or straw wattles. Long-term erosion control measures such as deep-rooted perennial vegetation, gravel mulch, riprap, geotextiles, gabion mats, concrete lining, or bio-reinforcement should be considered.

11.1.5 Fill Materials and Reuse of On-site Soils

On-site and imported soils that exhibit relatively low plasticity indices and very low to low expansive potential are generally suitable for re-use as engineered fill. Relatively low plasticity indices are defined as a PI value of 15, or less, as evaluated by ASTM D4318. Based on laboratory test results, the on-site soils are generally non-plastic to low plasticity (PI of zero (non-plastic) to six). As such, it is our opinion that many of the on-site soils will be suitable for re-use as engineered fill during construction. The Contractor should perform additional testing either prior to or during construction to better understand the soil conditions. Fill soils not suitable for re-use as engineered fill can be re-used in non-structural areas (e.g., landscaping, etc.).

In addition, suitable fill should not include organic material, construction debris, or other non-soil fill materials. Clay lumps and rock particles should not be larger than four inches in dimension. This material should be disposed of off-site or in non-structural areas.

Engineered fill materials in contact with ferrous metals should also have low corrosion potential (minimum resistivity more than 2,000 ohm-cm, chloride content less than 25 parts per million [ppm]). Engineered fill material in contact with concrete should have a soluble sulfate content of less than 0.1 percent.

11.1.6 Subgrade Preparation

As stated previously, our borings disclosed near-surface alluvial soils generally consisting of silty sand, well-graded sand with silt, and clayey sand. Based on the results of our explorations and laboratory testing, the on-site soils exhibit potential for volume changes upon inundation with water and may be compressible. Our laboratory measured collapse potential tested on relatively undisturbed specimens was on the order of five to seven percent for the easterly borings B-3 through B-5 and on the order of two to three percent in the remaining (westerly located) borings. Accordingly, we recommend that the developer considers the following mitigation measures:

- Relatively light-weight improvements with column loads less than 100 thousand pounds (kips) and wall loads less than four kips/linear foot should be placed on a zone of engineered fill extending:
 - For shallow foundations (spread footings): 5 to 10 feet below existing grade; and
 - For slab-on-grade, mat foundations, post tensioned slabs, flatwork and pavements: three to five feet below existing grade.
- Heavier-loaded, or settlement sensitive structures with column loads exceeding 100 kips and wall loads exceeding four kips/linear foot may need ground improvement techniques such as stone columns extending to 30 feet below existing grade or deep foundations (concrete drilled piers) extending to a competent layer generally below 40 feet depth.
- Deep facility foundations such as mat foundations (for wet wells) below a depth of 10 feet: ground improvements should be designed on a case-by-case basis.
- For pipelines, the zone of engineered fill should extend five to seven feet below the pipe bedding. Additional ground improvements involving geogrid layer installation may reduce the overexcavation depth and should be designed on a case-by-case basis.
- Fill embankments should be placed on prepared subgrade. The overexcavation depths will depend on the fill thickness and proposed development, and may vary between two and five feet.

The engineered fill placed in the subgrade improvement zone should be moisture-conditioned and compacted as discussed in Section 11.1.7. The fill thickness should be measured from the bottom of the foundation or the aggregate base (AB) layer, where applicable. This subgrade improvement should extend laterally three to five feet beyond the foundation/pavement footprint.

After the overexcavation described above is finished and prior to the placement of engineered fill, exposed surfaces from excavations should be carefully evaluated by Ninyo & Moore for the presence of soft, loose, or wet soils that were not removed as part of the improvement process. This evaluation should consist of probing and visual observation of the excavation bottom. For larger areas under future pavements, proof-rolling of the over-excavation bottom using heavily loaded trucks or construction equipment should be considered. Based on this evaluation, additional remediation may be needed. This could include further scarification of the exposed surface. This additional remediation, if needed, should be addressed by the geotechnical consultant during the earthwork operations.

11.1.7 Fill Placement and Compaction

Engineered fill soils should be moisture-conditioned within the moisture range shown below in Table 2 and mechanically compacted to the percent compaction shown. Engineered fill should generally be placed in 8-inch-thick loose lifts such that each lift is firm and non-yielding under the weight of construction equipment.

Table 2 – Compaction Recommendations		
Engineered Fill Description	Percent Compaction per ASTM D698	Moisture Content
Below foundations, slab-on-grade, mat foundations, exterior flatwork, and pavement	95 percent	±2 percent of optimum
AB	100 percent	±2 percent of optimum
Trench Backfill – within 2 feet below pavements	100 percent	±2 percent of optimum
Trench Backfill – deeper than 2 feet below pavement	95 percent	±2 percent of optimum
Pipe Bedding/Pipe Zone	95 percent	±2 percent of optimum

An earthwork (shrinkage) factor of 10 to 20 percent is estimated. This shrinkage factor range represents an average of the material tested and assumes that materials excavated from the site will be placed as fill. Potential bidders should consider this in preparing

estimates and should review the available data to make their own conclusions regarding excavation conditions.

11.2 Seismic Design Considerations

Design of the proposed improvements should be performed in accordance with the requirements of the governing jurisdictions and applicable building codes. Table 3 presents the seismic design parameters for the site in accordance with the International Building Code (IBC) guidelines and adjusted maximum considered earthquake spectral response acceleration parameters evaluated using the California's Office of Statewide Health Planning and Development Seismic Design Maps (web-based).

Table 3 – IBC Seismic Design Criteria	
Site Coefficients and Spectral Response Acceleration Parameters	Values
Site Class	D
Site Coefficient, F_a	1.585
Site Coefficient, F_v	2.40
Mapped Spectral Response Acceleration at 0.2-second Period, S_s	0.269 g
Mapped Spectral Response Acceleration at 1.0-second Period, S_1	0.083 g
Spectral Response Acceleration at 0.2-second Period Adjusted for Site Class, S_{MS}	0.426 g
Spectral Response Acceleration at 1.0-second Period Adjusted for Site Class, S_{M1}	0.200 g
Design Spectral Response Acceleration at 0.2-second Period, S_{DS}	0.284 g
Design Spectral Response Acceleration at 1.0-second Period, S_{D1}	0.133 g

11.3 Corrosion

The corrosion potential of the on-site materials was analyzed to evaluate its potential effect on the foundations and structures. Corrosion potential was evaluated using the results of laboratory testing of a soil sample obtained during our subsurface evaluation that was considered representative of soils at the subject site.

Laboratory testing consisted of pH, minimum electrical resistivity, and chloride and soluble sulfate contents. The pH and minimum electrical resistivity tests were performed in general accordance with Arizona Test 236c, while sulfate and chloride tests were performed in accordance with Arizona Test 733 and 736, respectively. The results of the corrosivity tests are presented in Appendix B.

The soil pH value of the tested samples ranged between 8.1 and 8.2, which is considered to be alkaline. The minimum electrical resistivity measured in the laboratory varied between 2,615 and 10,050 ohm-cm, which is considered to be non-corrosive to ferrous metals. The

chloride content of the samples tested ranged between 10 and 17 ppm, which is also considered to be non-corrosive environment to ferrous metals. The soluble sulfate content of the soil samples tested was 0.005 percent by weight, which is considered to represent negligible sulfate exposure for concrete.

The results of the laboratory testing indicate that the on-site materials are non-corrosive to ferrous materials. However, based on our experience in the project area, it is possible that soils with variable corrosivity characteristics may be encountered at the site and should be evaluated during construction. A corrosion specialist should be consulted for further recommendations.

11.4 Concrete

Laboratory chemical tests performed on soil samples indicated sulfate content of approximately 0.005 percent by weight. Based on American Concrete Institute, the on-site soils should be considered to represent negligible sulfate exposure to concrete.

We recommend the use of Type II cement for construction of concrete structures at this site. Due to potential uncertainties as to the use of reclaimed irrigation water, or topsoil that may contain higher sulfate contents, pozzolan or admixtures designed to increase sulfate resistance may be considered.

The concrete should have a water-cementitious materials ratio of no more than 0.50 by weight for normal weight aggregate concrete. The structural engineer should select the concrete design strength based on the project specific loading conditions. Higher strength concrete may be selected for increased durability and resistance to slab curling and shrinkage cracking.

We recommend that concrete cover over reinforcing steel for foundations be in accordance with the recommendations of the structural engineer. The structural engineer should be consulted for additional concrete specifications.

11.5 Water Control and Drainage Guidelines

As indicated earlier in this report, many of the on-site soils are sensitive to moisture fluctuations and may exhibit hydro-collapse upon inundation, as well as increased compressibility at higher degrees of saturation. Measures such as the subgrade preparation recommended in this report are designed to reduce the settlement potential of the subgrade soils within the foundation influence zone. However, except for deep foundations, such measures may not be sufficient to reduce structural movements to tolerable limits unless strict control of potential sub-surface

water leaks into the ground and/or adequate surface drainage measures are instituted in the project's design, construction, and operation phases.

The risk of sub-surface water leaks may be reduced by enhanced quality control performed during the utility construction and close monitoring of the utility performance during the facility operation.

Surface drainage measures include providing positive drainage conditions to divert water away from the structures and off of paved surfaces. Surface water should not be permitted to drain toward the structures or to pond adjacent to footings or on flatwork or pavement areas. Positive drainage for this project is defined as a slope of two or more percent for a distance of five or more feet away from the structures. Roof gutters should be installed on structures. Downspouts should discharge to drainage systems away from structures, pavements, and flatwork.

Further drainage recommendations include the following:

- Roof drain downspouts should be tight-lined to an appropriate outlet such as a storm drain or the street. If tight-lining of the roof drains is not practicable, they should discharge approximately five feet away from the structure or onto flatwork (with flexible sealant in its joints), which slopes away from the structure. Roof drains should not be allowed to discharge onto the ground surface near the building foundations.
- If planters are constructed adjacent to the building, we recommend that these planters be waterproofed and equipped with drains tight-lined to an appropriate drainage outlet.
- We recommend that low-water-use (desert-type) landscaping be utilized on site, particularly within five feet of the building and hardscaped areas.

Beneath the perimeter of any structure, utility trenches should be backfilled with either compacted non-pervious fill material (pea gravel or clean sand backfill should be avoided in these areas) or lean concrete to reduce water infiltration into the interior of the building. Special care should be taken during installation of sub-floor water and sewer lines to reduce the possibility of leaks.

12 ADDITIONAL GEOTECHNICAL STUDY

We recommend that a detailed geotechnical study be conducted during the final design stage and prior to project construction to better evaluate the subsurface conditions within the project site. Ninyo & Moore will be available to provide such services, if requested.

13 LIMITATIONS

The field evaluation, laboratory testing, and geotechnical analyses presented in this geotechnical report have been conducted in general accordance with current practice and the standard of care exercised by geotechnical consultants performing similar tasks in the project area. No warranty, expressed or implied, is made regarding the conclusions, recommendations, and opinions presented in this report. There is no evaluation detailed enough to reveal every subsurface condition. Variations may exist and conditions not observed or described in this report may be encountered during construction. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface evaluation will be performed upon request. Please also note that our evaluation was limited to assessment of the geotechnical aspects of the project, and did not include evaluation of structural issues, environmental concerns, or the presence of hazardous materials.

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

This report is intended for design purposes only. It does not provide sufficient data to prepare an accurate bid by contractors. It is suggested that the bidders and their geotechnical consultant perform an independent evaluation of the subsurface conditions in the project areas. The independent evaluations may include, but not be limited to, review of other geotechnical reports prepared for the adjacent areas, site reconnaissance, and additional exploration and laboratory testing.

Our conclusions, recommendations, and opinions are based on an analysis of the observed site conditions. If geotechnical conditions different from those described in this report are encountered, our office should be notified and additional recommendations, if warranted, will be provided upon request. It should be understood that the conditions of a site could change with time as a result of natural processes or the activities of man at the subject site or nearby sites. In addition, changes to the applicable laws, regulations, codes, and standards of practice may occur due to government action or the broadening of knowledge. The findings of this report may, therefore, be invalidated over time, in part or in whole, by changes over which Ninyo & Moore has no control.

This report is intended exclusively for use by the client. Any use or reuse of the findings, conclusions, and/or recommendations of this report by parties other than the client is undertaken at said parties' sole risk.

14 REFERENCES

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FIGURES

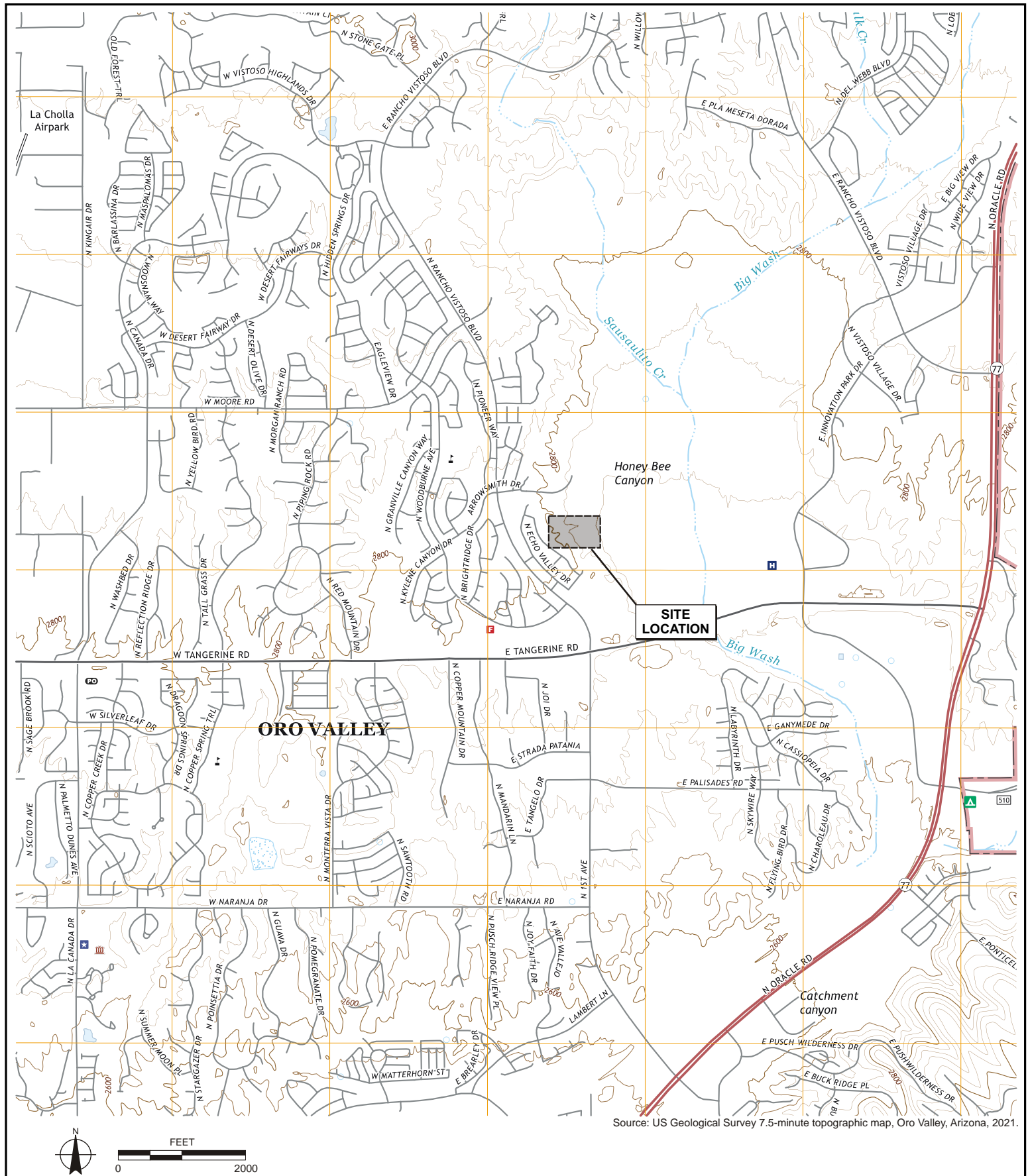


FIGURE 1

SITE LOCATION

RANCHO VISTOSO PARCEL 5-R
ORO VALLEY, ARIZONA



FIGURE 2

BORING LOCATIONS

RANCHO VISTOSO PARCEL 5-R
ORO VALLEY, ARIZONA

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APPENDIX A

Boring Logs

APPENDIX A

BORING LOGS

Field Procedure for the Collection of Disturbed Samples

Disturbed soil samples were obtained in the field using the following methods.

Bulk Samples

Bulk samples of representative earth materials were obtained from the exploratory borings. The samples were bagged and transported to the laboratory for testing.

The Standard Penetration Test (SPT) Sampler

Disturbed drive samples of earth materials were obtained by means of a Standard Penetration Test sampler. The sampler is composed of a split barrel with an external diameter of 2 inches and an unlined internal diameter of 1-3/8 inches. The sampler was driven into the ground 12 to 18 inches with a 140-pound hammer falling freely from a height of 30 inches in general accordance with ASTM D1586. The blow counts were recorded for every 6 inches of penetration; the blow counts reported on the log are those for the last 12 inches of penetration. Soil samples were observed and removed from the sampler, bagged, sealed and transported to the laboratory for testing.

Field Procedure for the Collection of Relatively Undisturbed Samples

Relatively undisturbed soil samples were obtained in the field using the following methods.

The Modified Split-Barrel Drive Sampler

The sampler, with an external diameter of 3.0 inches, was lined with 1-inch long, thin brass rings with inside diameters of approximately 2.4 inches. The sample barrel was driven into the ground with the weight of a hammer or the Kelly bar of the drill rig in general accordance with ASTM D3550. The driving weight was permitted to fall freely. The approximate length of the fall, the weight of the hammer or bar, and the number of blows per foot of driving are presented on the boring log as an index to the relative resistance of the materials sampled. The samples were removed from the sample barrel in the brass rings, sealed, and transported to the laboratory for testing.

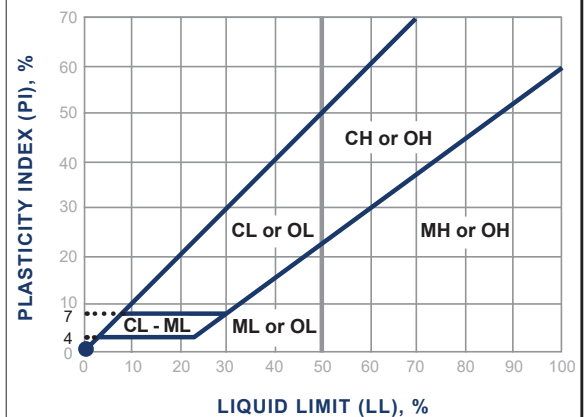
Soil Classification Chart Per ASTM D 2488

Primary Divisions			Secondary Divisions	
			Group Symbol	Group Name
COARSE-GRAINED SOILS more than 50% retained on No. 200 sieve	GRAVEL more than 50% of coarse fraction retained on No. 4 sieve	CLEAN GRAVEL less than 5% fines	GW	well-graded GRAVEL
			GP	poorly graded GRAVEL
		GRAVEL with DUAL CLASSIFICATIONS 5% to 12% fines	GW-GM	well-graded GRAVEL with silt
			GP-GM	poorly graded GRAVEL with silt
			GW-GC	well-graded GRAVEL with clay
			GP-GC	poorly graded GRAVEL with
		GRAVEL with FINES more than 12% fines	GM	silty GRAVEL
			GC	clayey GRAVEL
			GC-GM	silty, clayey GRAVEL
	SAND 50% or more of coarse fraction passes No. 4 sieve	CLEAN SAND less than 5% fines	SW	well-graded SAND
			SP	poorly graded SAND
		SAND with DUAL CLASSIFICATIONS 5% to 12% fines	SW-SM	well-graded SAND with silt
			SP-SM	poorly graded SAND with silt
			SW-SC	well-graded SAND with clay
			SP-SC	poorly graded SAND with clay
		SAND with FINES more than 12% fines	SM	silty SAND
			SC	clayey SAND
			SC-SM	silty, clayey SAND
FINE-GRAINED SOILS 50% or more passes No. 200 sieve	SILT and CLAY liquid limit less than 50%	INORGANIC	CL	lean CLAY
			ML	SILT
			CL-ML	silty CLAY
		ORGANIC	OL (PI > 4)	organic CLAY
			OL (PI < 4)	organic SILT
	SILT and CLAY liquid limit 50% or more	INORGANIC	CH	fat CLAY
			MH	elastic SILT
		ORGANIC	OH (plots on or above "A"-line)	organic CLAY
			OH (plots below "A"-line)	organic SILT
		Highly Organic Soils	PT	Peat

Grain Size

Description		Sieve Size	Grain Size	Approximate Size
Boulders		> 12"	> 12"	Larger than basketball-sized
Cobbles		3 - 12"	3 - 12"	Fist-sized to basketball-sized
Gravel	Coarse	3/4 - 3"	3/4 - 3"	Thumb-sized to fist-sized
	Fine	#4 - 3/4"	0.19 - 0.75"	Pea-sized to thumb-sized
Sand	Coarse	#10 - #4	0.075 - 0.19"	Rock-salt-sized to pea-sized
	Medium	#40 - #10	0.017 - 0.075"	Sugar-sized to rock-salt-sized
	Fine	#200 - #40	0.0029 - 0.017"	Flour-sized to sugar-sized
Fines		Passing #200	< 0.0029"	Flour-sized and smaller

Plasticity Chart



Apparent Density - Coarse-Grained Soil

Apparent Density	Spooling Cable or Cathead		Automatic Trip Hammer	
	SPT (blows/foot)	Modified Split Barrel (blows/foot)	SPT (blows/foot)	Modified Split Barrel (blows/foot)
Very Loose	≤ 4	≤ 8	≤ 3	≤ 5
Loose	5 - 10	9 - 21	4 - 7	6 - 14
Medium Dense	11 - 30	22 - 63	8 - 20	15 - 42
Dense	31 - 50	64 - 105	21 - 33	43 - 70
Very Dense	> 50	> 105	> 33	> 70

Consistency - Fine-Grained Soil

Consistency	Spooling Cable or Cathead		Automatic Trip Hammer	
	SPT (blows/foot)	Modified Split Barrel (blows/foot)	SPT (blows/foot)	Modified Split Barrel (blows/foot)
Very Soft	< 2	< 3	< 1	< 2
Soft	2 - 4	3 - 5	1 - 3	2 - 3
Firm	5 - 8	6 - 10	4 - 5	4 - 6
Stiff	9 - 15	11 - 20	6 - 10	7 - 13
Very Stiff	16 - 30	21 - 39	11 - 20	14 - 26
Hard	> 30	> 39	> 20	> 26

Ninyo & Moore

Geotechnical & Environmental Sciences Consultants

USCS METHOD OF SOIL CLASSIFICATION

BORING LOG EXPLANATION SHEET

DEPTH (feet)	Bulk Driven SAMPLES	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	
0							Bulk sample.
							Modified split-barrel drive sampler.
							No recovery with modified split-barrel drive sampler.
							Sample retained by others.
							Standard Penetration Test (SPT).
5							No recovery with a SPT.
	XX/XX						Shelby tube sample. Distance pushed in inches/length of sample recovered in inches.
							No recovery with Shelby tube sampler.
							Continuous Push Sample.
10							Seepage.
							Groundwater encountered during drilling.
							Groundwater measured after drilling.
						SM	MAJOR MATERIAL TYPE (SOIL):
							Solid line denotes unit change.
						CL	Dashed line denotes material change.
15							Attitudes: Strike/Dip b: Bedding c: Contact j: Joint f: Fracture F: Fault cs: Clay Seam s: Shear bss: Basal Slide Surface sf: Shear Fracture sz: Shear Zone sbs: Shear Bedding Surface
20							The total depth line is a solid line that is drawn at the bottom of the boring.

DEPTH (feet)	SAMPLES		BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED 6/25/23 BORING NO. B-1	
	Bulk	Driven						GROUND ELEVATION 2,763' ± (MSL) SHEET 1 OF 3	METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (GSI)
								DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"	
								SAMPLED BY MH LOGGED BY MH REVIEWED BY SDN	
DESCRIPTION/INTERPRETATION									
0							SW-SM	ALLUVIUM: Brown, dry, medium dense, well-graded SAND with silt; few gravel.	
5								Few to little gravel.	
10							SM	Brown, dry, dense, silty SAND; few gravel.	
15									
20									

FIGURE B- 1

DEPTH (feet)	SAMPLES		BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED 6/25/23 BORING NO. B-1	
	Bulk	Driven						GROUND ELEVATION 2,763' ± (MSL) SHEET 3 OF 3	
								METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (GSI)	
								DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"	
								SAMPLED BY MH LOGGED BY MH REVIEWED BY SDN	
DESCRIPTION/INTERPRETATION									
40							SM	ALLUVIUM (Continued): Brown, dry, very dense, silty SAND; few gravel.	
45			50/5"						
			50/4"						
50								Total Depth = 48.8 feet. Groundwater not encountered during drilling. Backfilled on 6/25/23 shortly after completion of drilling.	
								Notes: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.	
								The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.	
55									
60									

FIGURE B- 3

DEPTH (feet)	SAMPLES		BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED 6/25/23 BORING NO. B-2		
	Bulk	Driven						GROUND ELEVATION 2,736' ± (MSL) SHEET 1 OF 3		
								METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (GSI)		
								DRIVE WEIGHT 140 lbs. (Automatic)	DROP 30"	
								SAMPLED BY MH	LOGGED BY MH	REVIEWED BY SDN
DESCRIPTION/INTERPRETATION										
0							SM	ALLUVIUM: Brown, dry, medium dense, silty SAND; few gravel.		
			16	1.0	111.4					
			7						Loose.	
5										
			24	2.2	111.5				Medium dense.	
			8							
10										
			41							
15										
			21						Dense.	
20										

FIGURE B- 4



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FIGURE B- 5

RANCHO VISTOSO PARCEL 5-R
ORO VALLEY, ARIZONA





















607834001 | 5/25

DEPTH (feet)	SAMPLES		BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED 6/25/23 BORING NO. B-2	
	Bulk	Driven						GROUND ELEVATION 2,736' ± (MSL) SHEET 3 OF 3	
								METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (GSI)	
								DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"	
								SAMPLED BY MH LOGGED BY MH REVIEWED BY SDN	
DESCRIPTION/INTERPRETATION									
40							SM	ALLUVIUM (Continued): Brown, dry, very dense, silty SAND; few gravel.	
								Dense.	
								Very dense.	
50								Total Depth = 50 feet. Groundwater not encountered during drilling. Backfilled on 6/25/23 shortly after completion of drilling.	
								Notes: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.	
								The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.	
55									
	</								

FIGURE B- 6

DEPTH (feet)	SAMPLES		BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED 6/24/23 BORING NO. B-3	
	Bulk	Driven						GROUND ELEVATION 2,712' ± (MSL) SHEET 1 OF 3	
		METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (GSI)							
		DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"							
		SAMPLED BY MH LOGGED BY MH REVIEWED BY SDN							
		DESCRIPTION/INTERPRETATION							
0							SM	ALLUVIUM: Brown, dry, loose, silty SAND; few gravel.	
			10	2.8	94.9				
			7						
5									
			15	3.7	100.4			Medium dense.	
			13						
10									
			21						
15									
			9						
20									

FIGURE B- 7

DEPTH (feet)	SAMPLES		BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED 6/24/23		BORING NO. B-3			
	Bulk	Driven						GROUND ELEVATION 2,712' ± (MSL)		SHEET 2 OF 3			
								METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (GSI)					
								DRIVE WEIGHT 140 lbs. (Automatic)		DROP 30"			
								SAMPLED BY MH		LOGGED BY MH		REVIEWED BY SDN	
								DESCRIPTION/INTERPRETATION					
20			26				SM	ALLUVIUM (Continued): Brown, dry, medium dense, silty SAND; few gravel.					
25													
													
													
			33					Very dense.					
30													
													
													
			50					Dense.					
35													
													
													
			45					Very dense.					
40													
													
													



DEPTH (feet)	SAMPLES		BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED 6/24/23 BORING NO. B-3	
	Bulk	Driven						GROUND ELEVATION 2,712' ± (MSL)	SHEET 3 OF 3
METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (GSI)									
DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"									
SAMPLED BY MH LOGGED BY MH REVIEWED BY SDN									
DESCRIPTION/INTERPRETATION									
40							SC	ALLUVIUM (Continued): Brown, dry, very dense, clayey SAND; few gravel.	
45			59					Dense.	
							SM	Brown, dry, very dense, silty SAND.	
50			58					Total Depth = 50 feet. Groundwater not encountered during drilling. Backfilled on 6/24/23 shortly after completion of drilling.	
								Notes: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.	
								The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.	
55									
60									

FIGURE B- 9



DEPTH (feet)	SAMPLES		BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED 6/24/23 BORING NO. B-4	
	Bulk	Driven						GROUND ELEVATION 2,710' ± (MSL) SHEET 1 OF 3	METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (GSI)
								DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"	
								SAMPLED BY MH LOGGED BY MH REVIEWED BY SDN	
DESCRIPTION/INTERPRETATION									
0							SM	ALLUVIUM: Brown, dry, loose, silty SAND; few gravel.	
			5						
			9	6.3	113.7				
5									
			8					Medium dense.	
			19	1.7	112.3				
10									
			8						
15									
			19						
20									

FIGURE B- 10

DEPTH (feet)	SAMPLES		BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED	BORING NO.		
	Bulk	Driven						6/24/23	B-4		
								GROUND ELEVATION	2,710' ± (MSL)	SHEET 2 OF 3	
								METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (GSI)			
								DRIVE WEIGHT	140 lbs. (Automatic)	DROP 30"	
								SAMPLED BY	MH	LOGGED BY MH	REVIEWED BY SDN
								DESCRIPTION/INTERPRETATION			
20							SM	ALLUVIUM (Continued): Brown, dry, medium dense, silty SAND; few gravel.			
25			9								
30			31								
35			13								
40			46					Dense.			

DEPTH (feet)	SAMPLES		BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED 6/24/23 BORING NO. B-4	
	Bulk	Driven						GROUND ELEVATION 2,710' ± (MSL) SHEET 3 OF 3	
								METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (GSI)	
								DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"	
								SAMPLED BY MH LOGGED BY MH REVIEWED BY SDN	
								DESCRIPTION/INTERPRETATION	
40							SM	ALLUVIUM (Continued): Brown, dry, dense, silty SAND; few gravel.	
								Very dense.	
45			49					Dense.	
50			58					Total Depth = 50 feet. Groundwater not encountered during drilling. Backfilled on 6/24/23 shortly after completion of drilling.	
								Notes: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.	
								The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.	
55									
60									

FIGURE B- 12



DEPTH (feet)	SAMPLES		BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED 6/24/23 BORING NO. B-5		
	Bulk	Driven						GROUND ELEVATION 2,708' ± (MSL) SHEET 1 OF 3		
								METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (GSI)		
								DRIVE WEIGHT 140 lbs. (Automatic)	DROP 30"	
								SAMPLED BY MH	LOGGED BY MH	REVIEWED BY SDN
DESCRIPTION/INTERPRETATION										
0							SM	ALLUVIUM: Brown, dry, loose, silty SAND; few gravel.		
12										
10								Medium dense.		
5								Loose.		
10										
8								Medium dense.		
10										
15										
17										
15										
20										

FIGURE B- 13

DEPTH (feet)	SAMPLES		BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED 6/24/23 BORING NO. B-5		
	Bulk	Driven						GROUND ELEVATION 2,708' ± (MSL) SHEET 2 OF 3	METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (GSI)	
								DRIVE WEIGHT 140 lbs. (Automatic)	DROP 30"	
								SAMPLED BY MH	LOGGED BY MH	REVIEWED BY SDN
DESCRIPTION/INTERPRETATION										
20							SM	ALLUVIUM (Continued): Brown, dry, medium dense, silty SAND; few gravel.		
			40							
25										
			23					Dense.		
30										
			71					Light brown; very dense.		
35										
			55							
40										

FIGURE B- 14

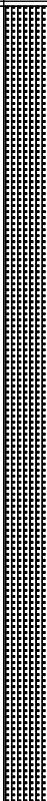
DEPTH (feet)	SAMPLES		BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED	BORING NO.					
	Bulk	Driven						6/24/23	B-5					
								GROUND ELEVATION	2,708' ± (MSL)		SHEET	3	OF	3
								METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (GSI)						
								DRIVE WEIGHT	140 lbs. (Automatic)		DROP	30"		
								SAMPLED BY	MH	LOGGED BY	MH	REVIEWED BY	SDN	
DESCRIPTION/INTERPRETATION														
40			62				SM	ALLUVIUM (Continued): Light brown, dry, very dense, silty SAND; few gravel.						
										Dense.				
45								Very dense.						
			58					Total Depth = 50 feet. Groundwater not encountered during drilling. Backfilled on 6/24/23 shortly after completion of drilling.						
50								Notes: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.						
								The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.						
55														
60														

FIGURE B- 15

DEPTH (feet)	SAMPLES		BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED 1/27/25 BORING NO. B-6	
	Bulk	Driven						GROUND ELEVATION 2,763' ± (MSL) SHEET 1 OF 2	
								METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (GSI)	
								DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"	
								SAMPLED BY ACM LOGGED BY ACM REVIEWED BY SDN	
DESCRIPTION/INTERPRETATION									
0							SP-SM	ALLUVIUM: Brown, dry, medium dense, poorly graded SAND with silt; few gravel.	
			9						
			14					Loose.	
5									
			11					Medium dense.	
			15	1.7	94.2		SM	Brown, dry, medium dense, silty SAND.	
10									
			21					Dense.	
15									
			32	2.4	105.3			Medium dense.	
20									

FIGURE B- 16


DEPTH (feet)	SAMPLES		BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED 1/27/25		BORING NO. B-6			
	Bulk	Driven						GROUND ELEVATION 2,763' ± (MSL)		SHEET 2 OF 2			
								METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (GSI)					
								DRIVE WEIGHT 140 lbs. (Automatic)		DROP 30"			
								SAMPLED BY ACM		LOGGED BY ACM		REVIEWED BY SDN	
DESCRIPTION/INTERPRETATION													
20			50/1"				SM	ALLUVIUM (continued): Brown, dry, very dense, silty SAND.					
25													
			94/11"				SP-SM	Brown, dry, very dense, poorly graded SAND with silt.					
30													
		</											

FIGURE B- 17

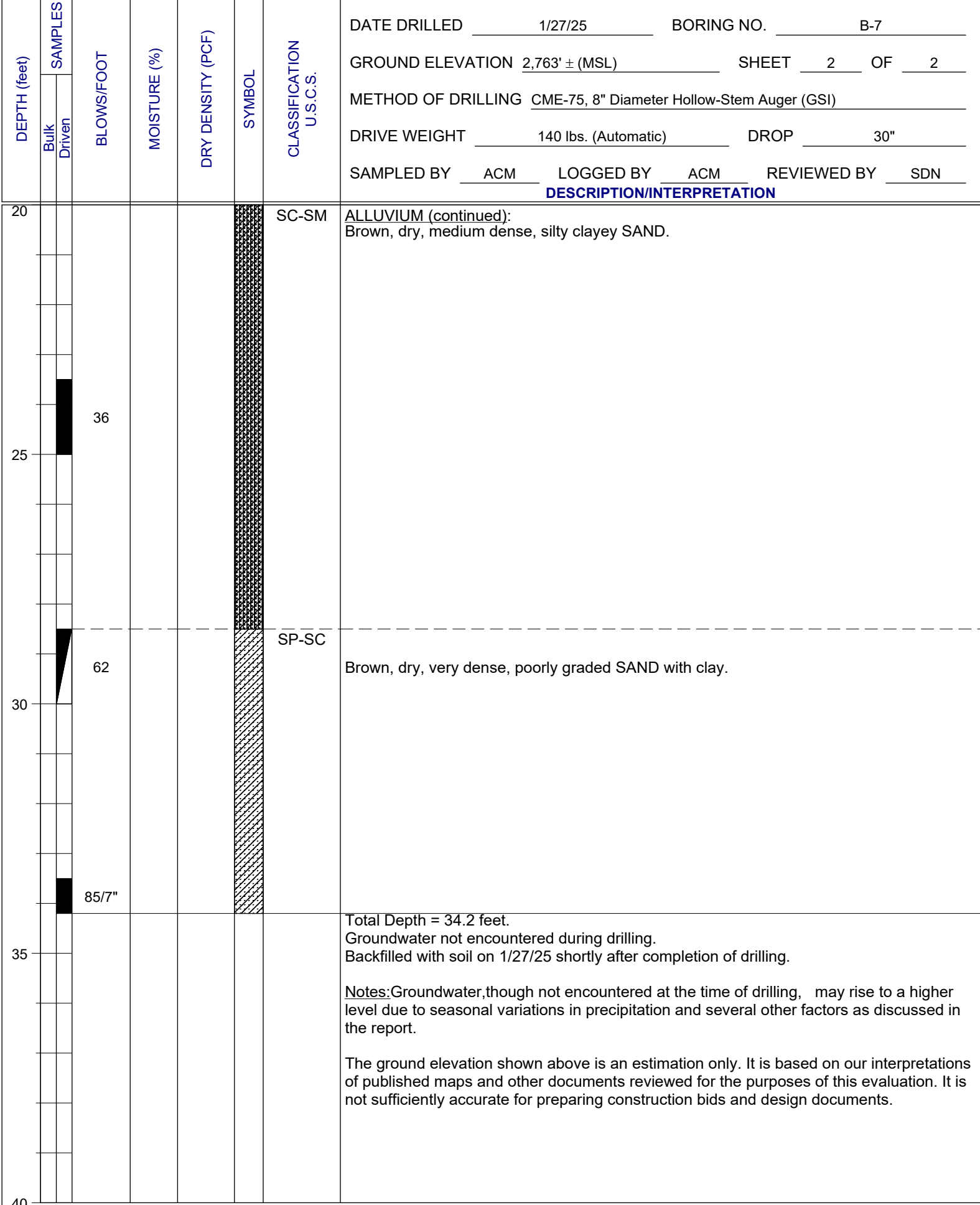


FIGURE B- 19
















DEPTH (feet)	SAMPLES		BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED 1/27/25 BORING NO. B-8		
	Bulk	Driven						GROUND ELEVATION 2,763' ± (MSL) SHEET 1 OF 3		
								METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (GSI)		
								DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"		
								SAMPLED BY ACM LOGGED BY ACM REVIEWED BY SDN		
								DESCRIPTION/INTERPRETATION		
0			12	1.5	111.0		SM	ALLUVIUM: Brown, dry, medium dense, silty SAND; few gravel.		
5			20	1.5	111.0		SM	Very dense.		
10			50/5"	1.5	111.0		SM	Dense, trace gravel.		
15			23	1.5	111.0		SM			
20			26	1.5	111.0		SC-SM	Brown, dry, medium dense, silty clayey SAND; trace gravel.		

FIGURE B- 20



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FIGURE B- 22

RANCHO VISTOSO PARCEL 5-R
ORO VALLEY, ARIZONA

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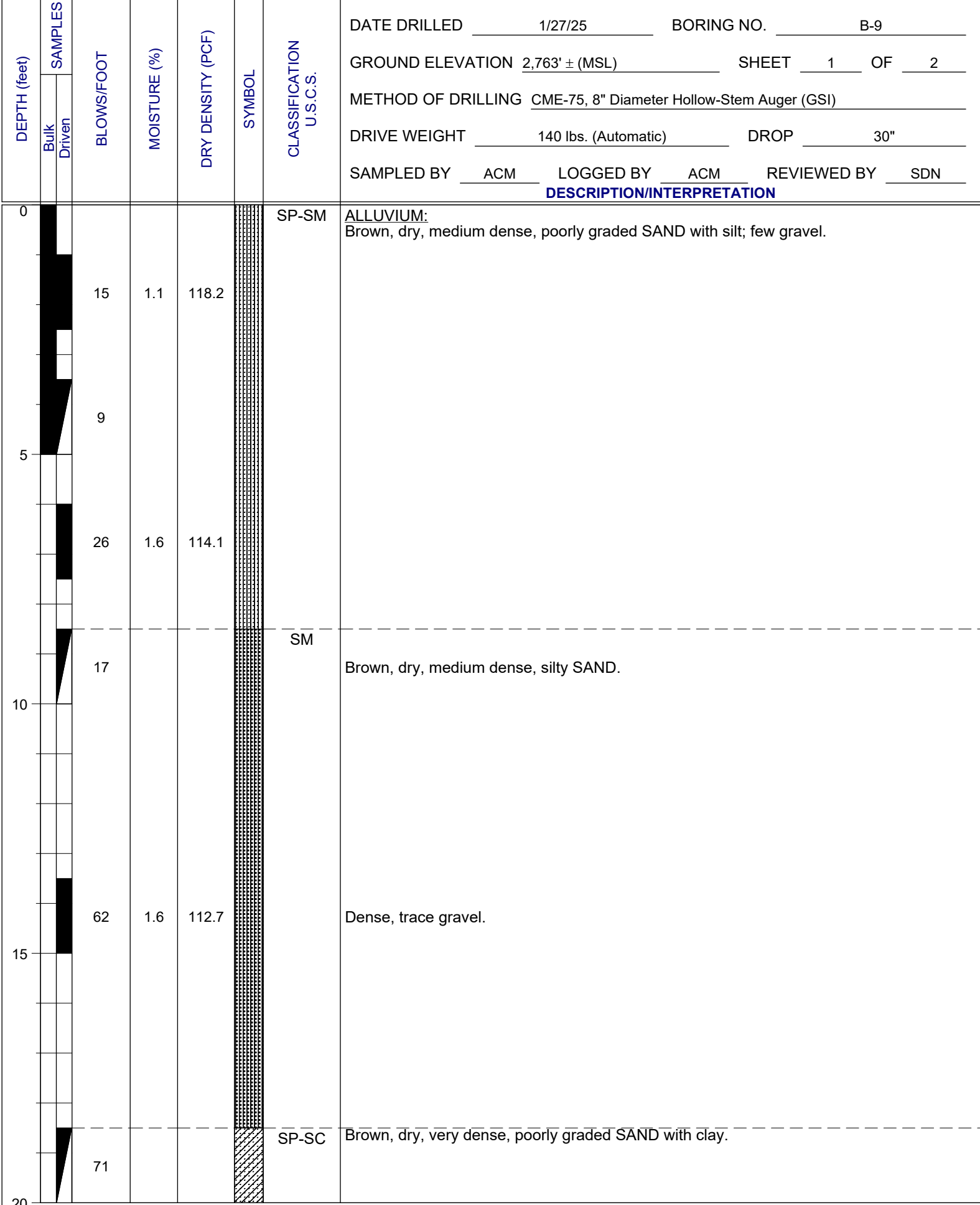


FIGURE B- 23



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FIGURE B- 24

RANCHO VISTOSO PARCEL 5-R
ORO VALLEY, ARIZONA

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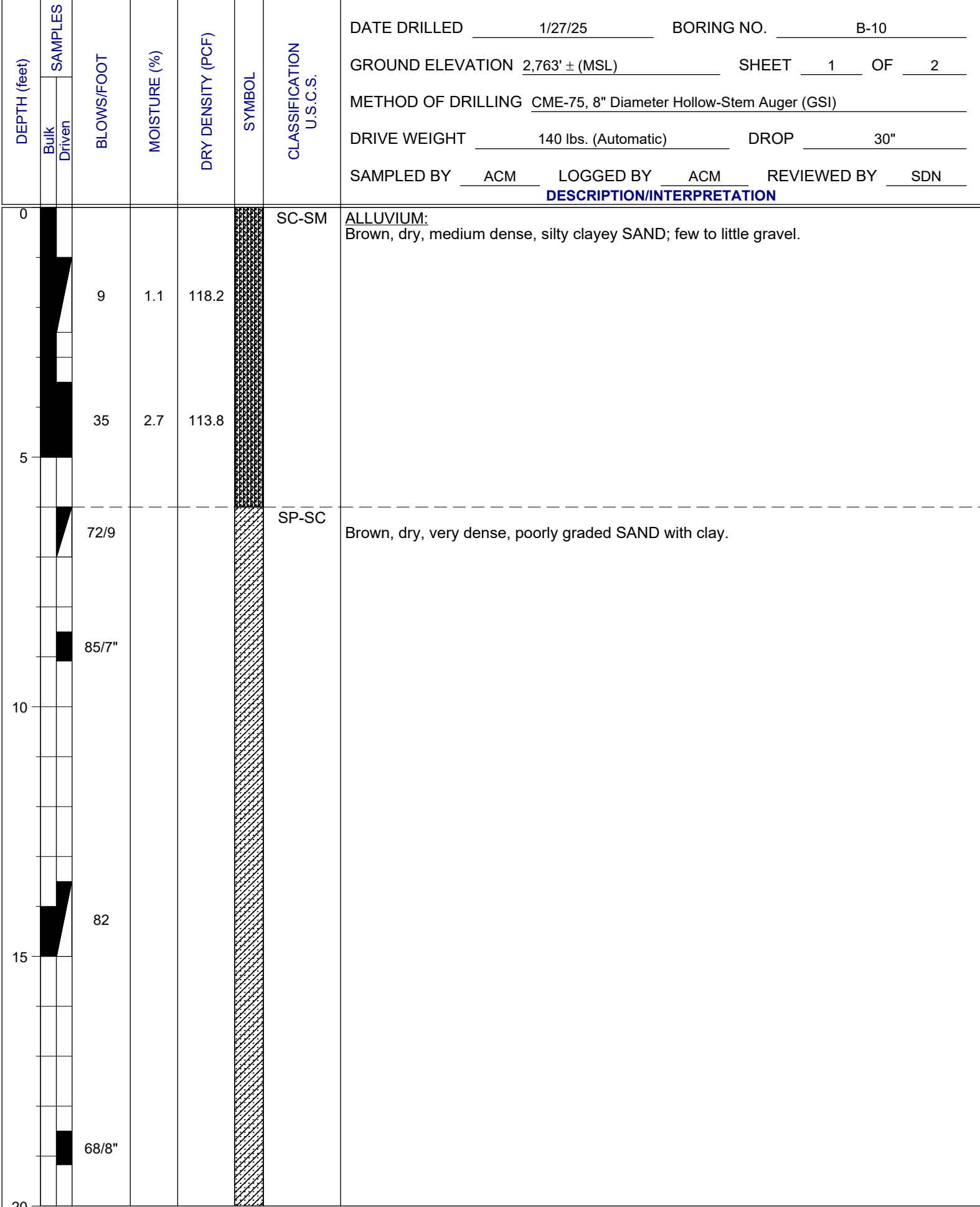


FIGURE B- 25

DEPTH (feet)	SAMPLES		BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED	BORING NO.	
	Bulk	Driven						1/27/25	B-10	
								GROUND ELEVATION	2,763' ± (MSL)	SHEET 2 OF 2
								METHOD OF DRILLING	CME-75, 8" Diameter Hollow-Stem Auger (GSI)	
								DRIVE WEIGHT	140 lbs. (Automatic)	DROP 30"
								SAMPLED BY	ACM	LOGGED BY ACM REVIEWED BY SDN
								DESCRIPTION/INTERPRETATION		
20							SP-SC	ALLUVIUM (continued): Brown, dry, very dense, poorly graded SAND with clay.		
25										
30										
35										
40										

Total Depth = 35 feet.
Groundwater not encountered during drilling.
Backfilled with soil on 1/27/25 shortly after completion of drilling.

Notes:Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.

The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.

FIGURE B- 26



APPENDIX B

Laboratory Testing

APPENDIX B

LABORATORY TESTING

Classification

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

In-Place Moisture and Density Tests

The moisture content and dry density of relatively undisturbed samples obtained from the exploratory borings were evaluated in general accordance with ASTM D2937. The test results are presented on the logs of the exploratory boring in Appendix A.

Gradation Analysis

Gradation analysis tests were performed on selected representative soil samples in general accordance with ASTM D422. The grain-size distribution curves are shown on Figures B-1 through B-13. These test results were utilized in evaluating the soil classifications in accordance with the USCS.

Atterberg Limits

Tests were performed on selected representative fine-grained soil samples to evaluate the liquid limit, plastic limit, and plasticity index in general accordance with ASTM D4318. These test results were utilized to evaluate the soil classification in accordance with the USCS. The test results and classifications are shown on Figures B-14 and B-15.

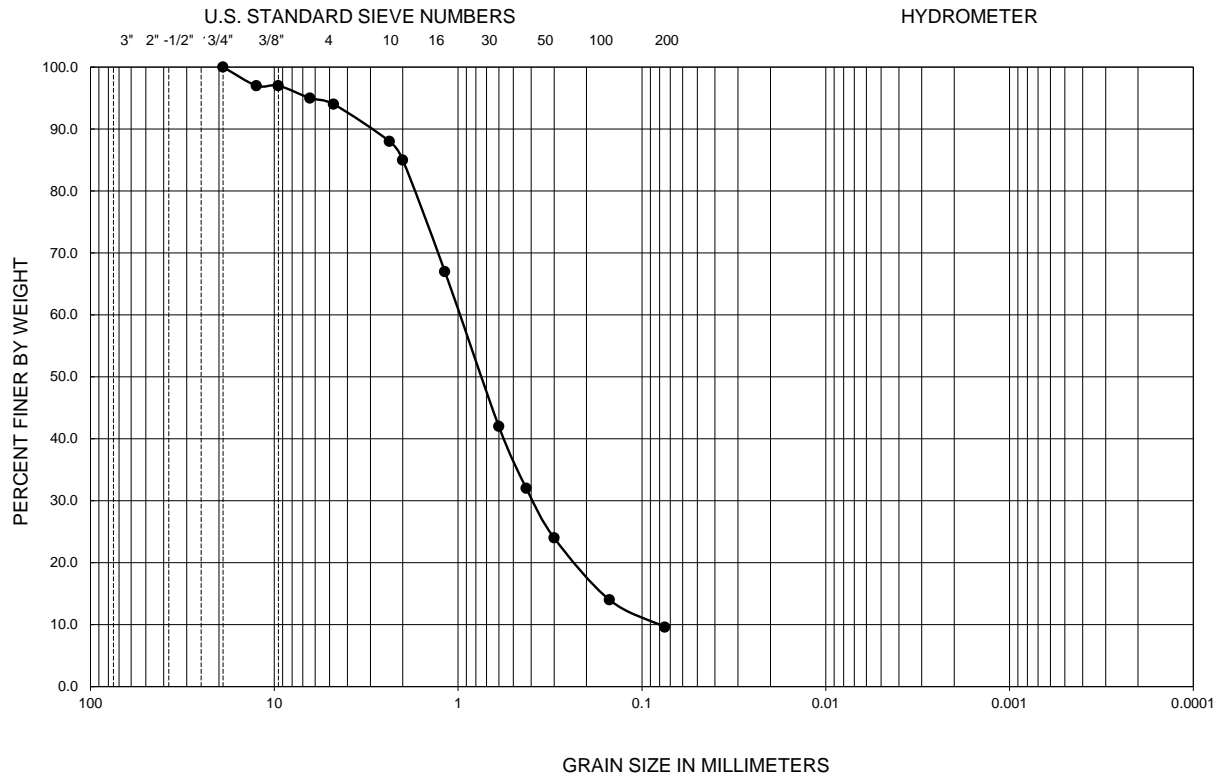
Consolidation Tests

Consolidation test was performed on selected relatively undisturbed soil samples in general accordance with ASTM D2435. The samples were inundated during testing to represent adverse field conditions. The percent of consolidation for each load cycle was recorded as a ratio of the amount of vertical compression to the original height of the samples. The results of the tests are summarized on Figures B-16 through B-27.

Soil Corrosivity Tests

Soil pH and resistivity tests were performed on representative samples in general accordance with Arizona Test Method 236c. The soluble sulfate and chloride content of the samples were evaluated in general accordance with Arizona Test Method 733 and Arizona Test Method 736, respectively. The test results are presented on Figure B-28.

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY

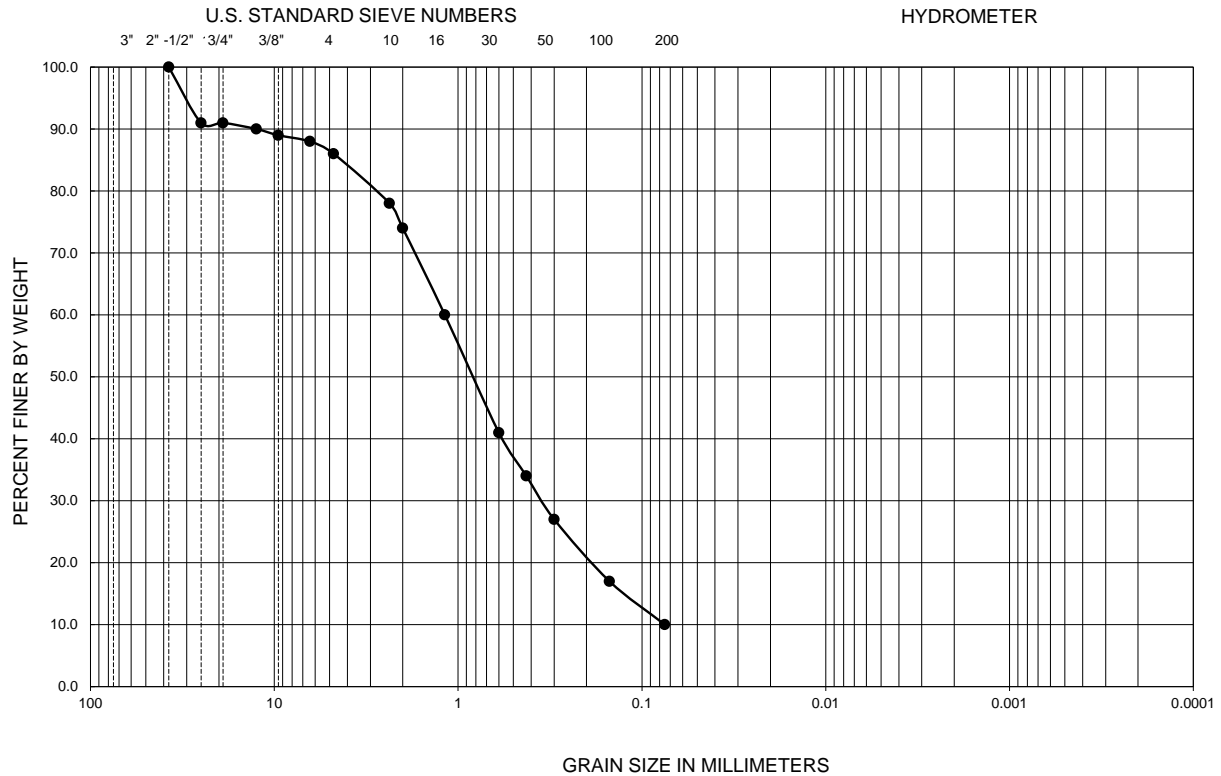


Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D ₁₀	D ₃₀	D ₆₀	C _u	C _c	Passing No. 200 (percent)	USCS
●	B-1	0.0-5.0	--	--	NP	0.079	0.396	0.98	12.4	2.0	9.6	SW-SM

NP - INDICATES NON-PLASTIC

PERFORMED IN GENERAL ACCORDANCE WITH ASTM C136 / D422

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D ₁₀	D ₃₀	D ₆₀	C _u	C _c	Passing No. 200 (percent)	USCS
●	B-1	8.5-10.0	--	--	NP	0.074	0.354	1.19	16.1	1.4	10.0	SW-SM

NP - INDICATES NON-PLASTIC

PERFORMED IN GENERAL ACCORDANCE WITH ASTM C136 / D422

FIGURE B-2

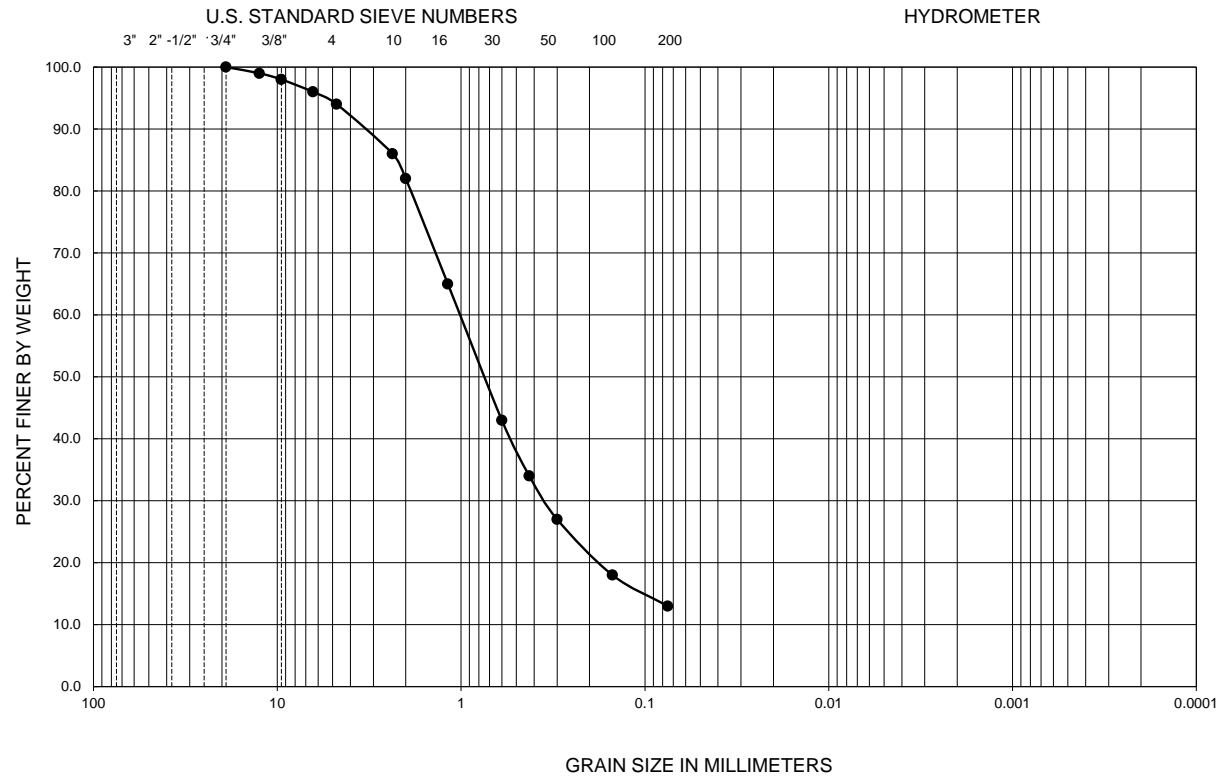
GRADATION TEST RESULTS

RANCHO VISTOSO PARCEL 5-R

ORO VALLEY, ARIZONA

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GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY

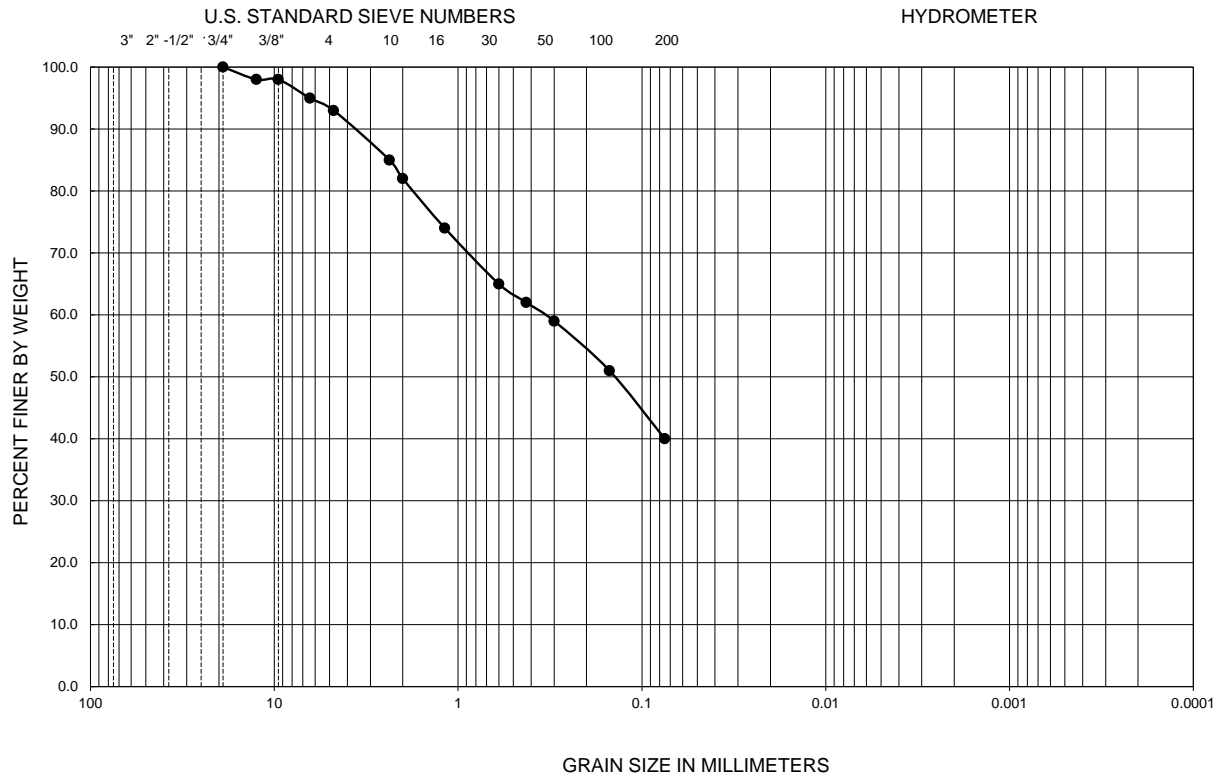


Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D ₁₀	D ₃₀	D ₆₀	C _u	C _c	Passing No. 200 (percent)	USCS
●	B-2	0.0-5.0	--	--	NP	--	0.354	1.02	--	--	13.0	SM

NP - INDICATES NON-PLASTIC

PERFORMED IN GENERAL ACCORDANCE WITH ASTM C136 / D422

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY

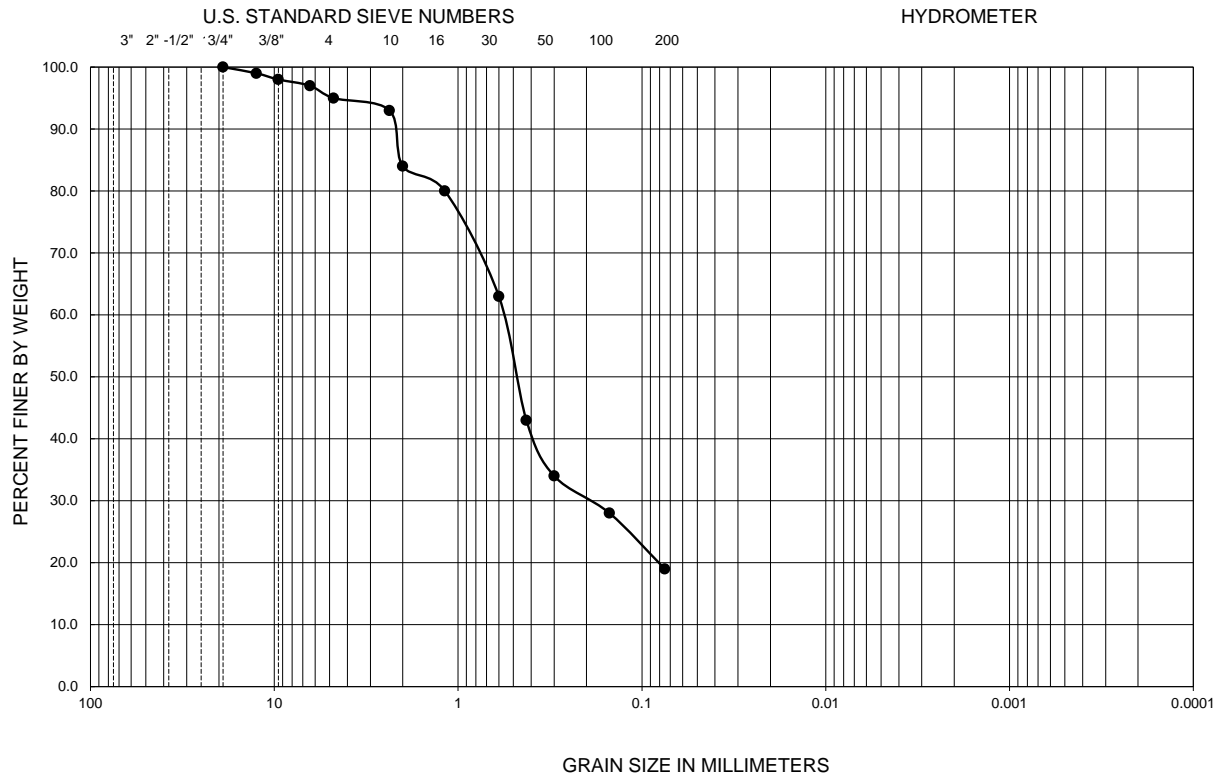


Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D ₁₀	D ₃₀	D ₆₀	C _u	C _c	Passing No. 200 (percent)	USCS
●	B-3	0.0-5.0	--	--	NP	--	--	0.34	--	--	40.0	SM

NP - INDICATES NON-PLASTIC

PERFORMED IN GENERAL ACCORDANCE WITH ASTM C136 / D422

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY

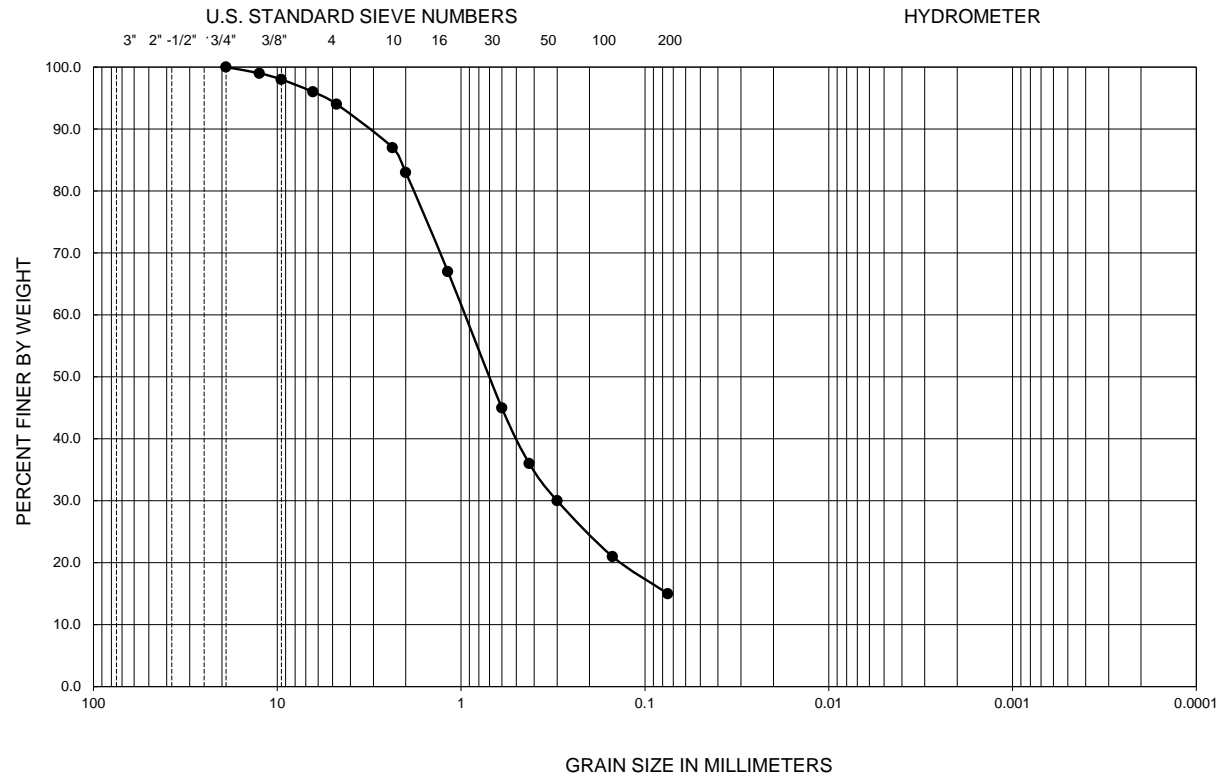


Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D ₁₀	D ₃₀	D ₆₀	C _u	C _c	Passing No. 200 (percent)	USCS
●	B-3	18.0-25.0	--	--	NP	--	0.342	1.07	--	--	14.0	SM

NP - INDICATES NON-PLASTIC

PERFORMED IN GENERAL ACCORDANCE WITH ASTM C136 / D422

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D ₁₀	D ₃₀	D ₆₀	C _u	C _c	Passing No. 200 (percent)	USCS
●	B-4	0.0-5.0	--	--	NP	--	0.305	0.95	--	--	15.0	SM

NP - INDICATES NON-PLASTIC

PERFORMED IN GENERAL ACCORDANCE WITH ASTM C136 / D422

FIGURE B-6

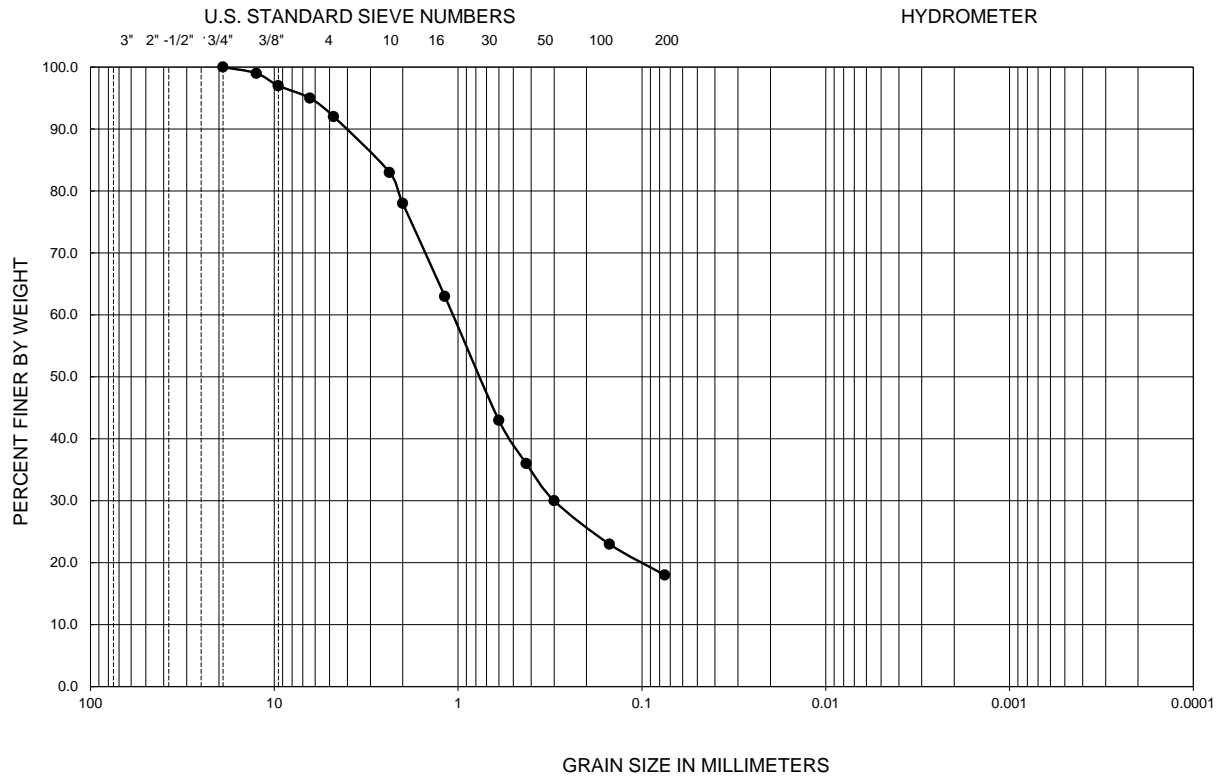
GRADATION TEST RESULTS

RANCHO VISTOSO PARCEL 5-R

ORO VALLEY, ARIZONA

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GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D ₁₀	D ₃₀	D ₆₀	C _u	C _c	Passing No. 200 (percent)	USCS
●	B-5	0.0-5.0	--	--	NP	--	0.305	1.07	--	--	18.0	SM

NP - INDICATES NON-PLASTIC

PERFORMED IN GENERAL ACCORDANCE WITH ASTM C136 / D422

FIGURE B-7

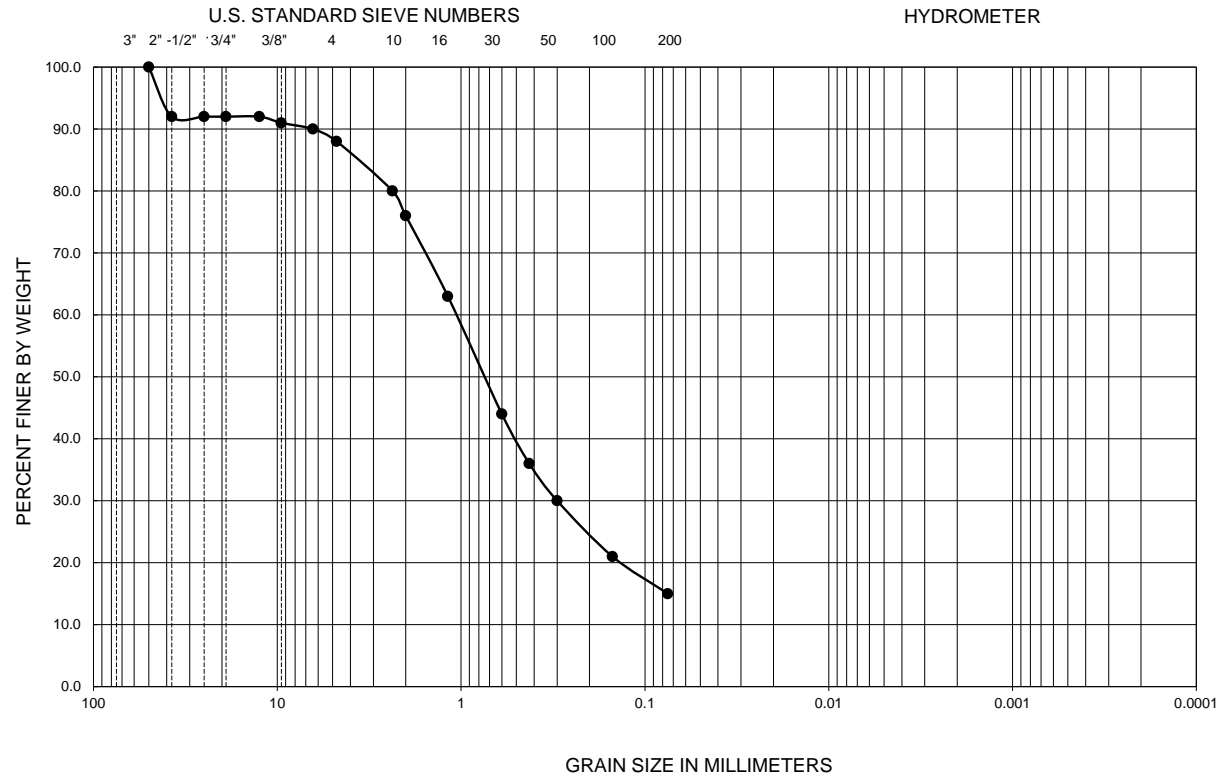
GRADATION TEST RESULTS

RANCHO VISTOSO PARCEL 5-R

ORO VALLEY, ARIZONA

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GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D ₁₀	D ₃₀	D ₆₀	C _u	C _c	Passing No. 200 (percent)	USCS
●	B-5	13.5-15.0	--	--	NP	--	0.305	1.07	--	--	15.0	SM

NP - INDICATES NON-PLASTIC

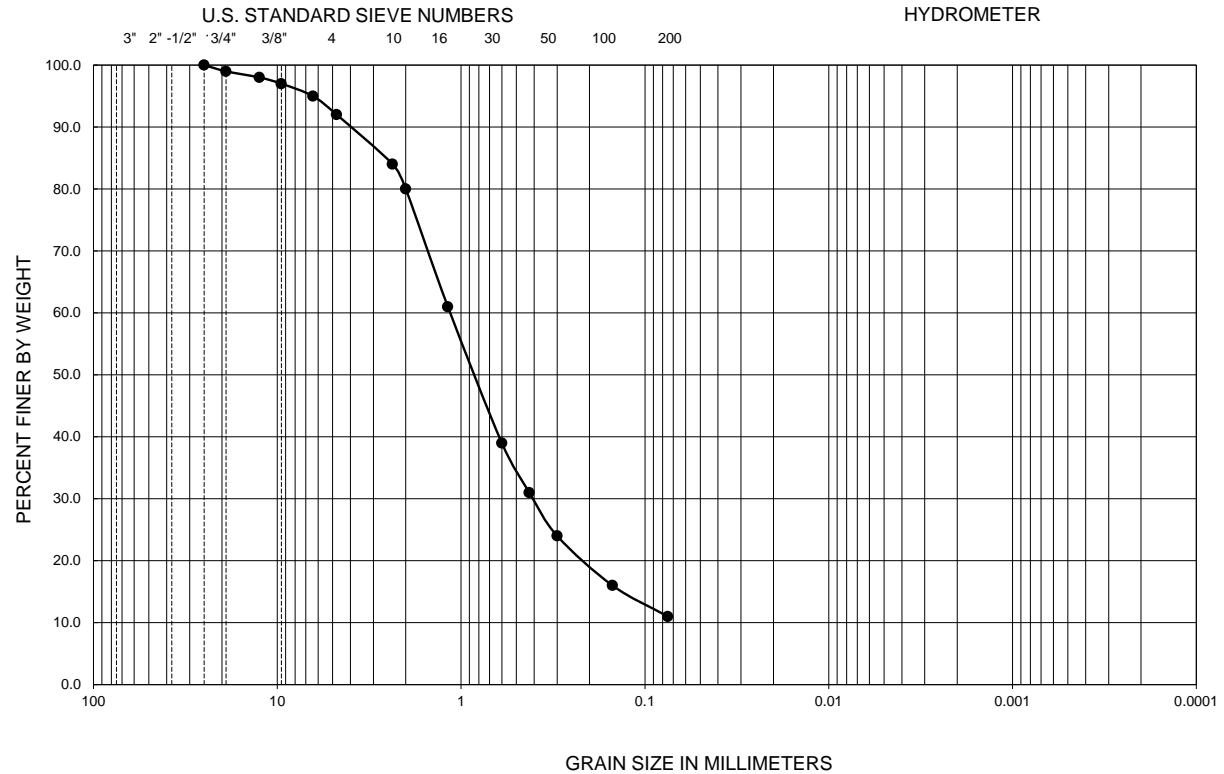
PERFORMED IN GENERAL ACCORDANCE WITH ASTM C136 / D422

FIGURE B-8

GRADATION TEST RESULTS

RANCHO VISTOSO PARCEL 5-R
ORO VALLEY, ARIZONA

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



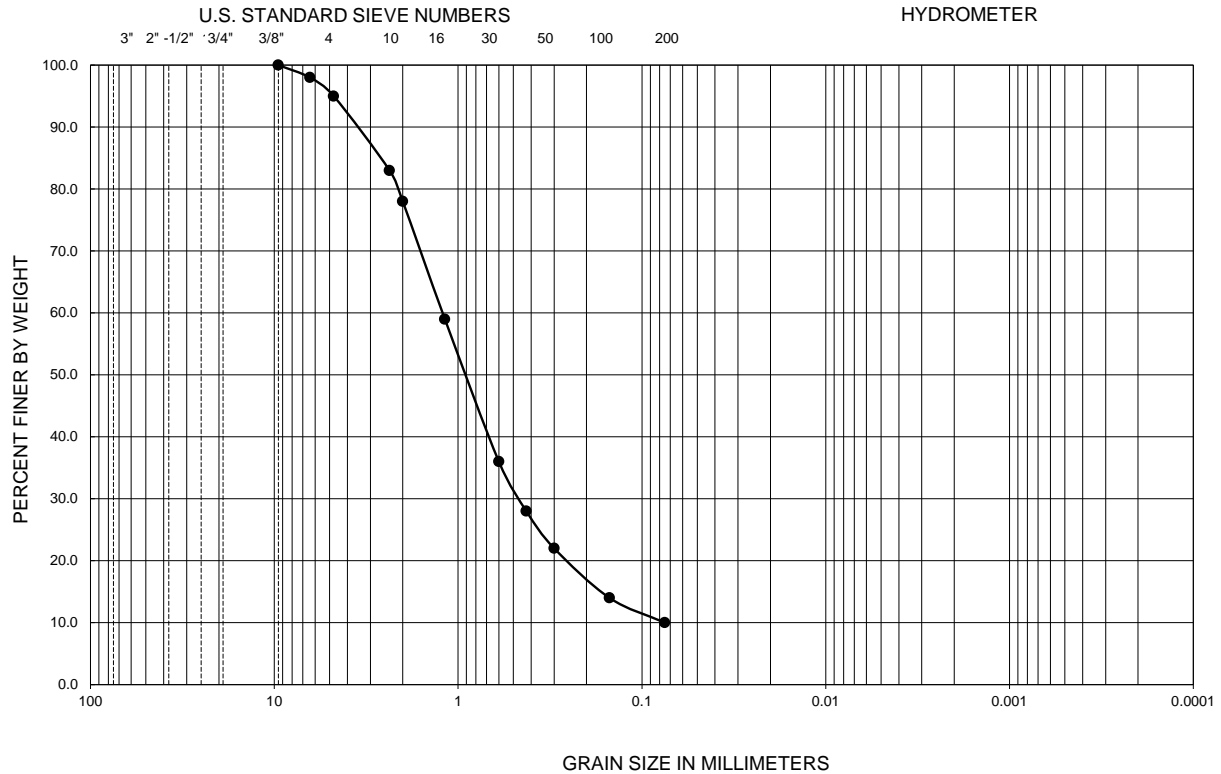
Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D ₁₀	D ₃₀	D ₆₀	C _u	C _c	Passing No. 200 (percent)	USCS
●	B-6	0.0-5.0	--	--	NP	--	0.411	1.16	--	--	11.0	SP-SM

NP - INDICATES NON-PLASTIC

PERFORMED IN GENERAL ACCORDANCE WITH ASTM C136 / D422



GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D ₁₀	D ₃₀	D ₆₀	C _u	C _c	Passing No. 200 (percent)	USCS
●	B-7	0.0-5.0	--	--	NP	0.074	0.466	1.23	16.6	2.4	10.0	SW-SM

NP - INDICATES NON-PLASTIC

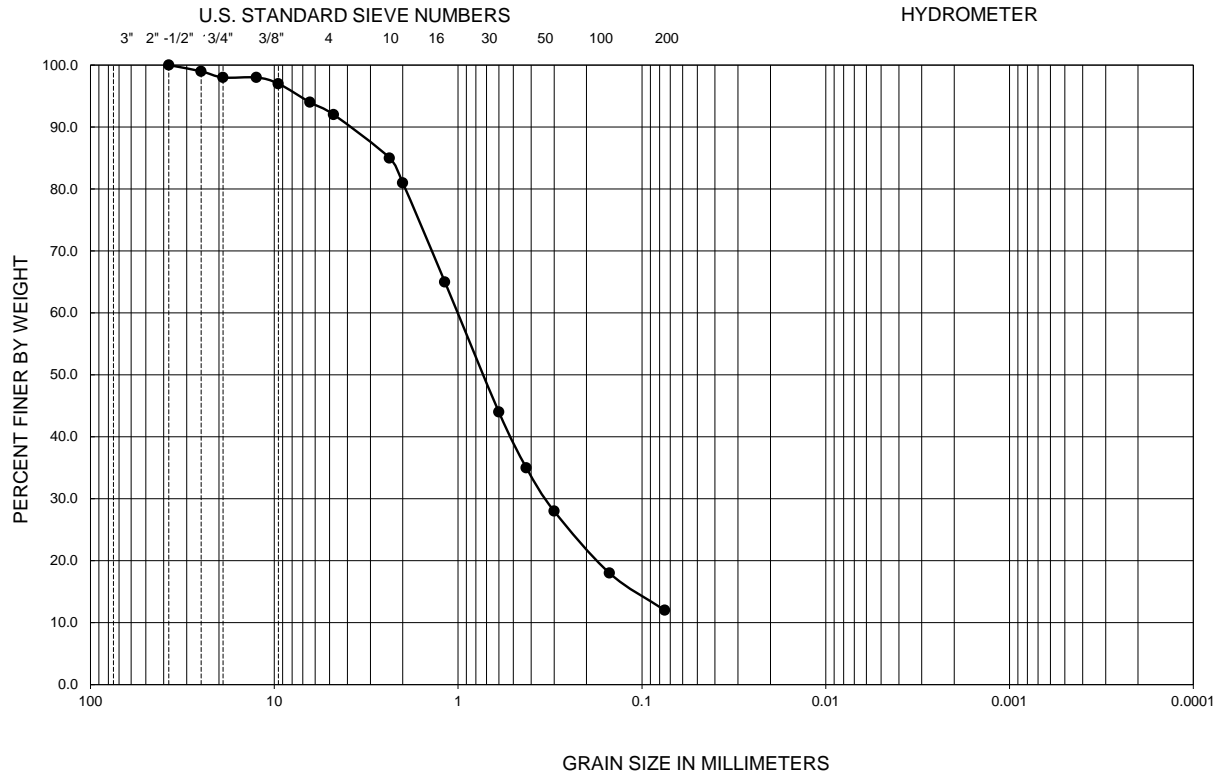
PERFORMED IN GENERAL ACCORDANCE WITH ASTM C136 / D422

FIGURE B-10

GRADATION TEST RESULTS

RANCHO VISTOSO PARCEL 5-R
ORO VALLEY, ARIZONA

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



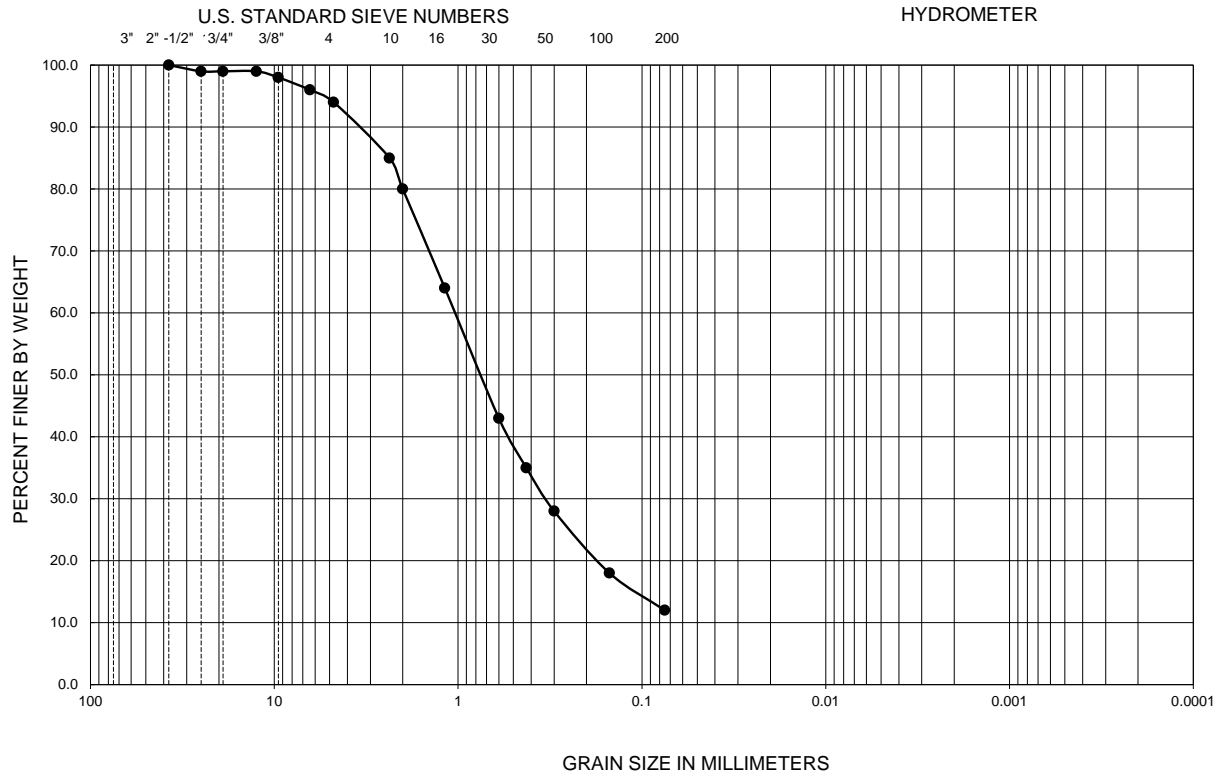
Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D ₁₀	D ₃₀	D ₆₀	C _u	C _c	Passing No. 200 (percent)	USCS
●	B-8	0.0-5.0	--	--	NP	--	0.337	1.01	--	--	12.0	SM

NP - INDICATES NON-PLASTIC

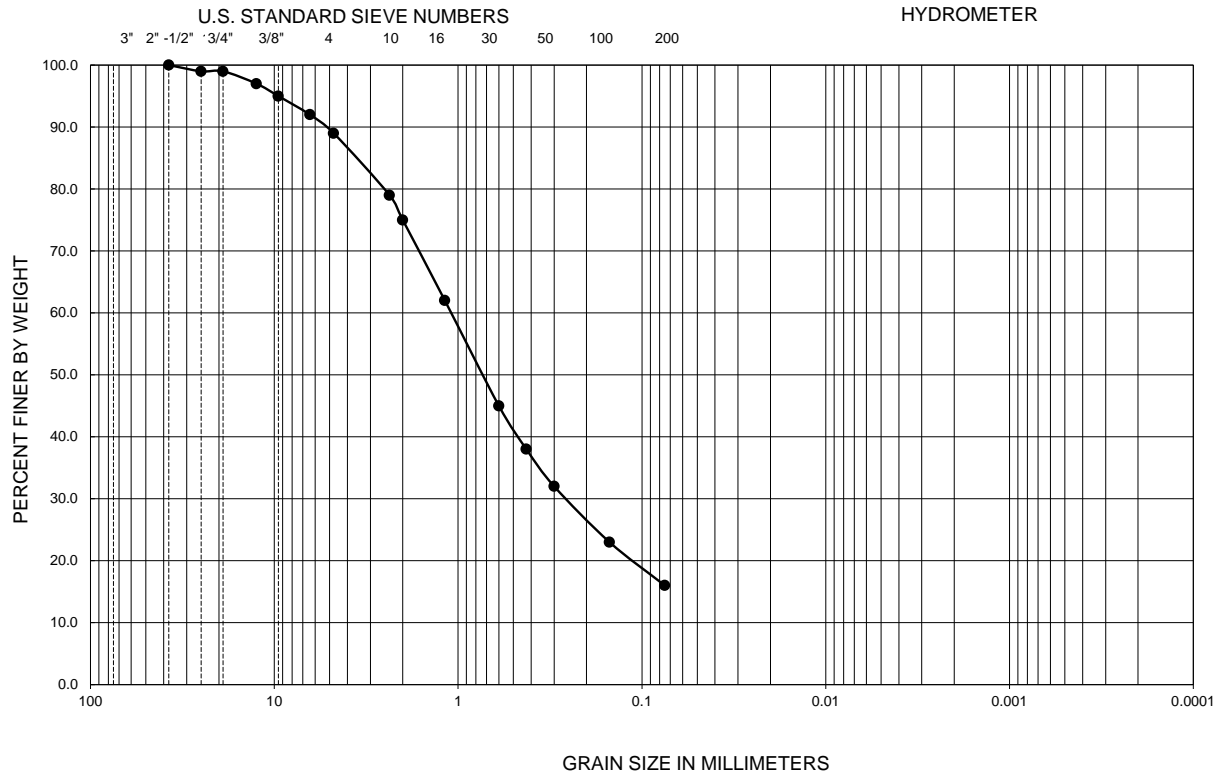
PERFORMED IN GENERAL ACCORDANCE WITH ASTM C136 / D422

FIGURE B-11

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D ₁₀	D ₃₀	D ₆₀	C _u	C _c	Passing No. 200 (percent)	USCS
●	B-10	0.0-5.0	23	17	6	--	0.260	1.10	--	--	16.0	SC-SM

PERFORMED IN GENERAL ACCORDANCE WITH ASTM C136 / D422

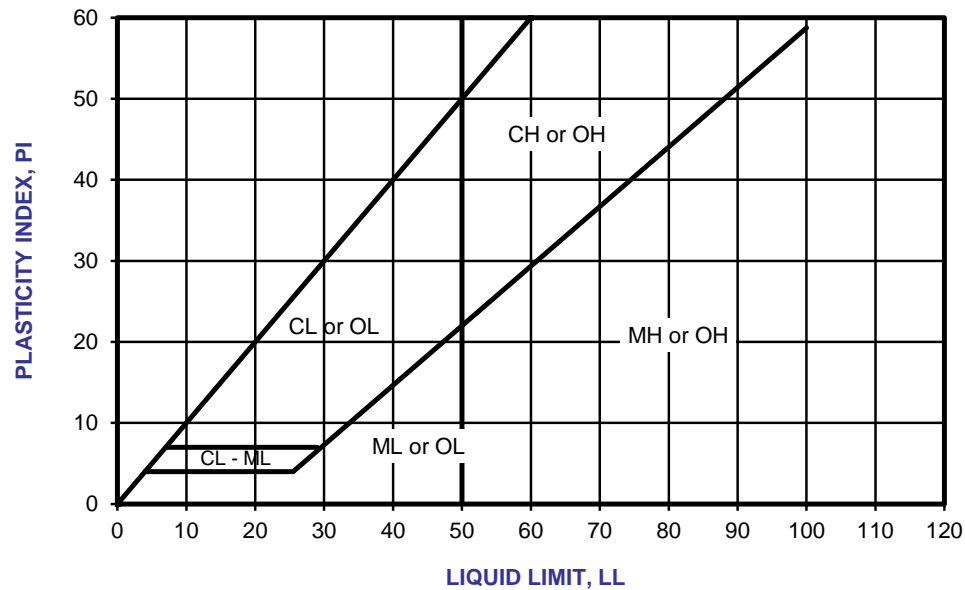
FIGURE B-13

GRADATION TEST RESULTS

RANCHO VISTOSO PARCEL 5-R
ORO VALLEY, ARIZONA

SYMBOL	LOCATION	DEPTH (ft)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	USCS CLASSIFICATION (Fraction Finer Than No. 40 Sieve)	USCS
●	B-1	0.0-5.0	--	--	NP	ML	SW-SM
■	B-1	8.5-10.0	--	--	NP	ML	SW-SM
◆	B-2	0.0-5.0	--	--	NP	ML	SM
○	B-3	0.0-5.0	--	--	NP	ML	SM
□	B-3	18.0-25.0	--	--	NP	ML	SM
△	B-4	0.0-5.0	--	--	NP	ML	SM
x	B-5	0.0-5.0	--	--	NP	ML	SM
+	B-5	13.5-15.0	--	--	NP	ML	SM

NP - INDICATES NON-PLASTIC



PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 4318

FIGURE B-14

ATTERBERG LIMITS TEST RESULTS

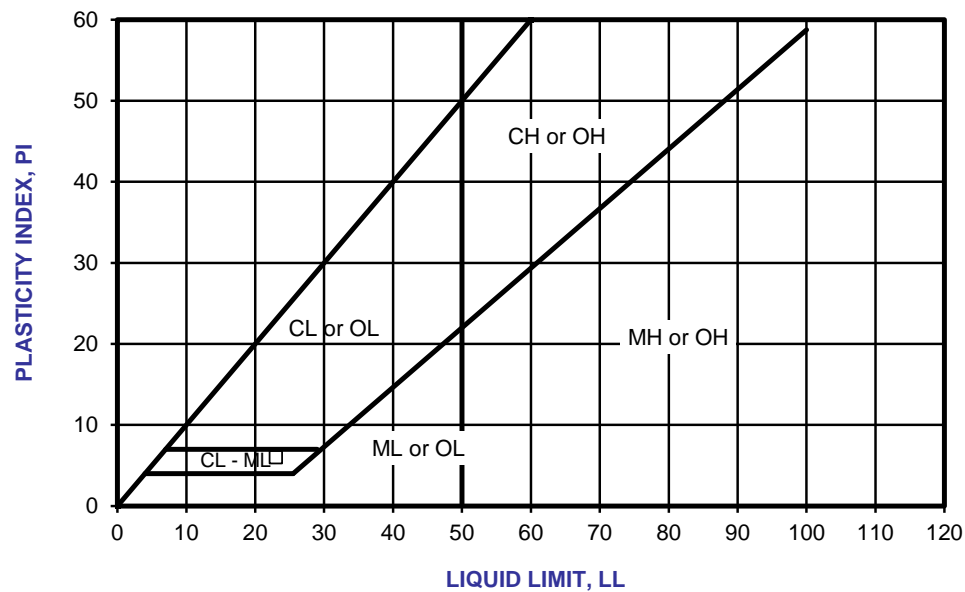
RANCHO VISTOSO PARCEL 5-R

ORO VALLEY, ARIZONA

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SYMBOL	LOCATION	DEPTH (ft)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	USCS CLASSIFICATION (Fraction Finer Than No. 40 Sieve)	USCS
●	B-6	0.0-5.0	--	--	NP	ML	SP-SM
■	B-7	0.0-5.0	--	--	NP	ML	SW-SM
◆	B-8	0.0-5.0	--	--	NP	ML	SM
○	B-9	0.0-5.0	--	--	NP	ML	SP-SM
□	B-10	0.0-5.0	23	17	6	CL-ML	SC-SM

NP - INDICATES NON-PLASTIC



PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 4318

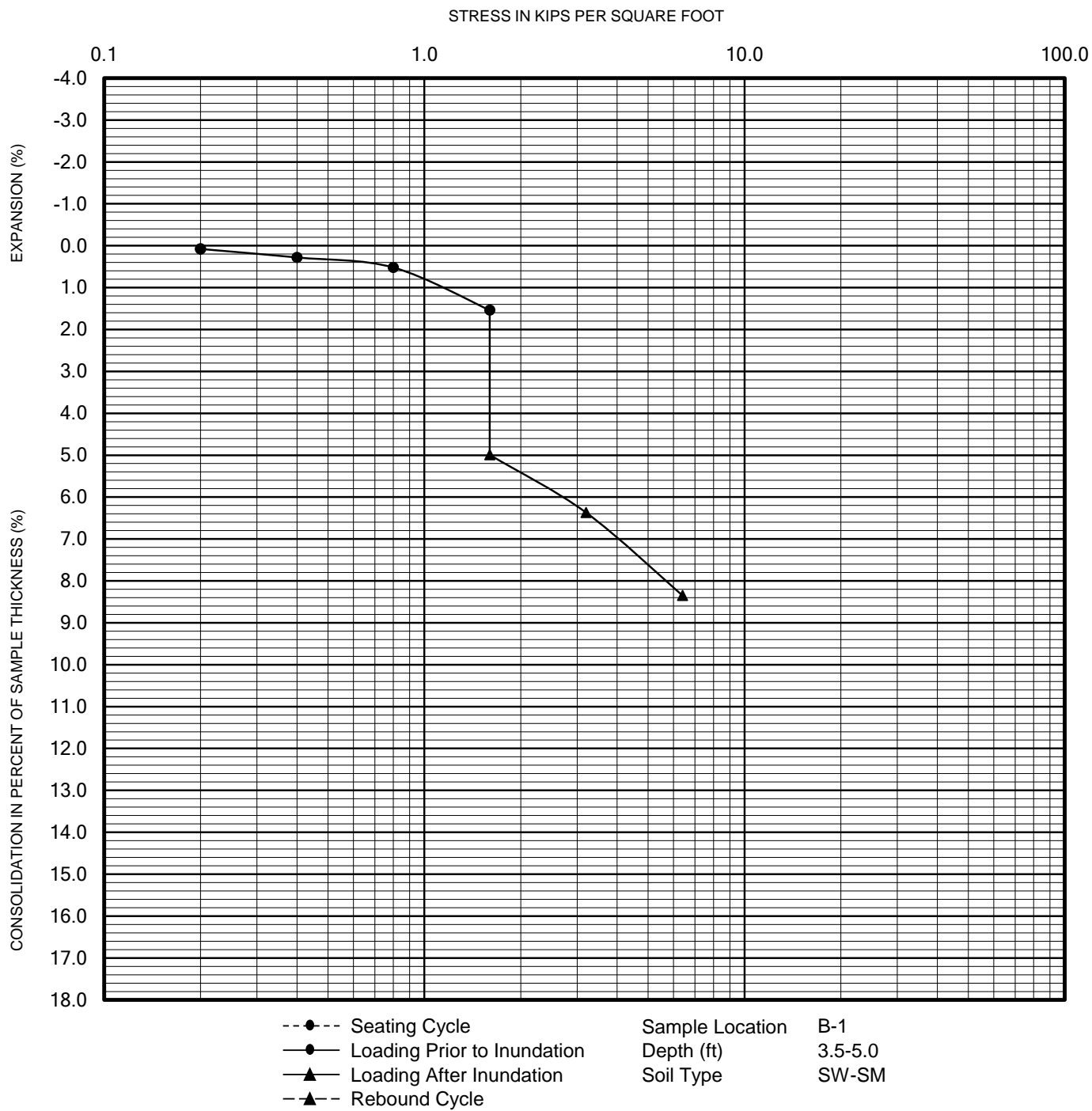
FIGURE B-15

ATTERBERG LIMITS TEST RESULTS

RANCHO VISTOSO PARCEL 5-R

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PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2435

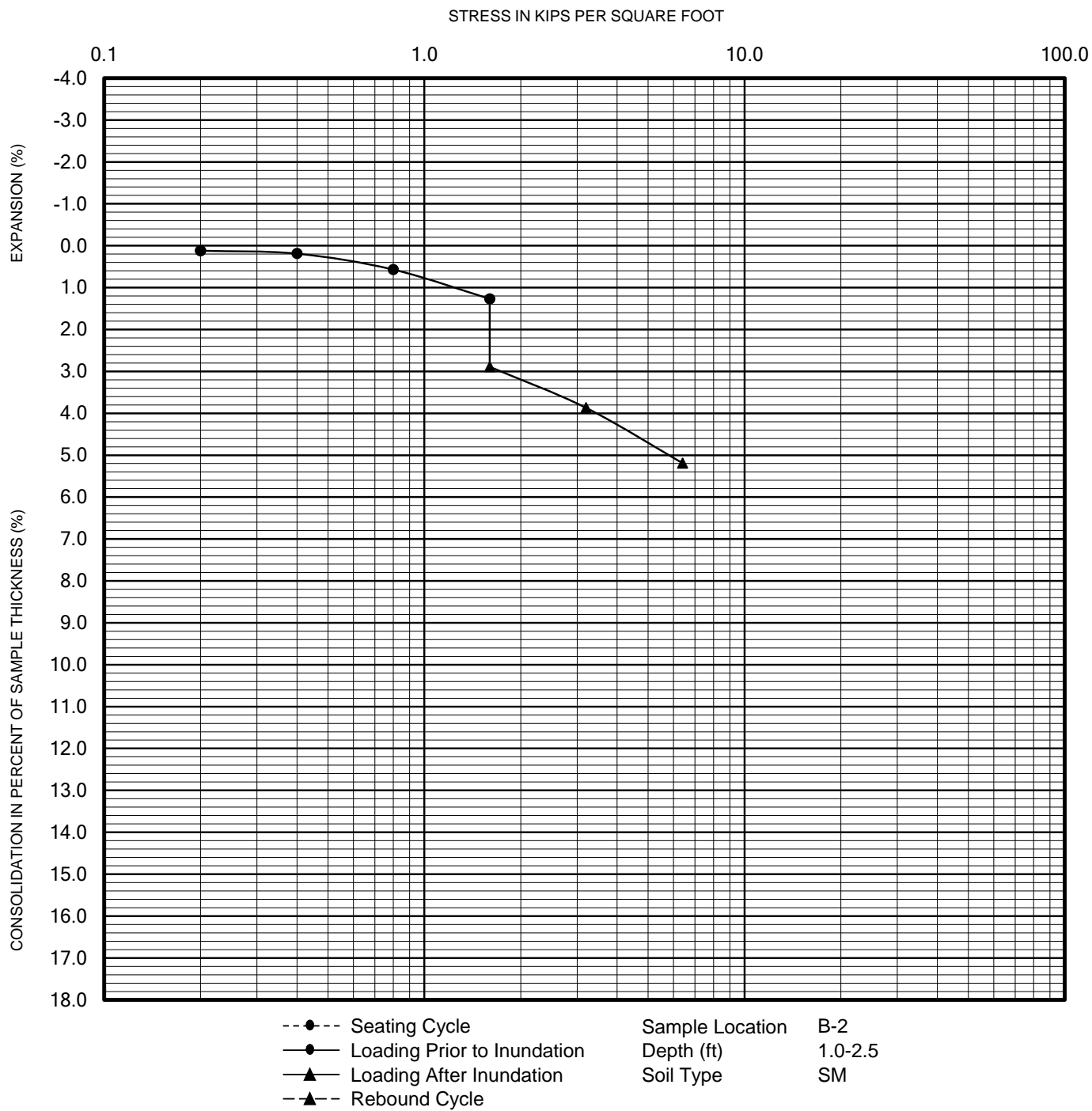
FIGURE B-16

CONSOLIDATION TEST RESULTS

RANCHO VISTOSO PARCEL 5-R

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PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2435

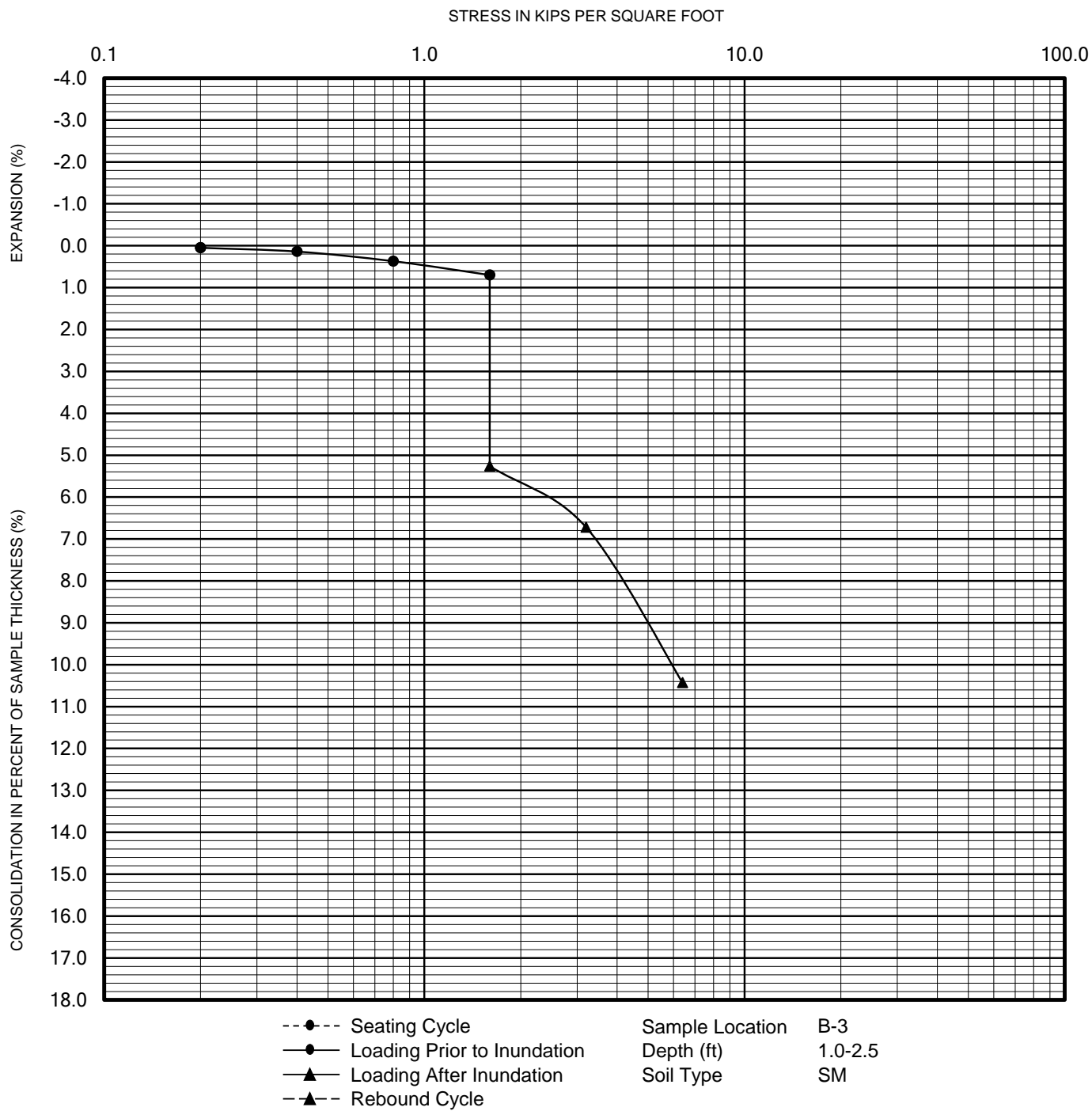
FIGURE B-17

CONSOLIDATION TEST RESULTS

RANCHO VISTOSO PARCEL 5-R

ORO VALLEY, ARIZONA

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PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2435

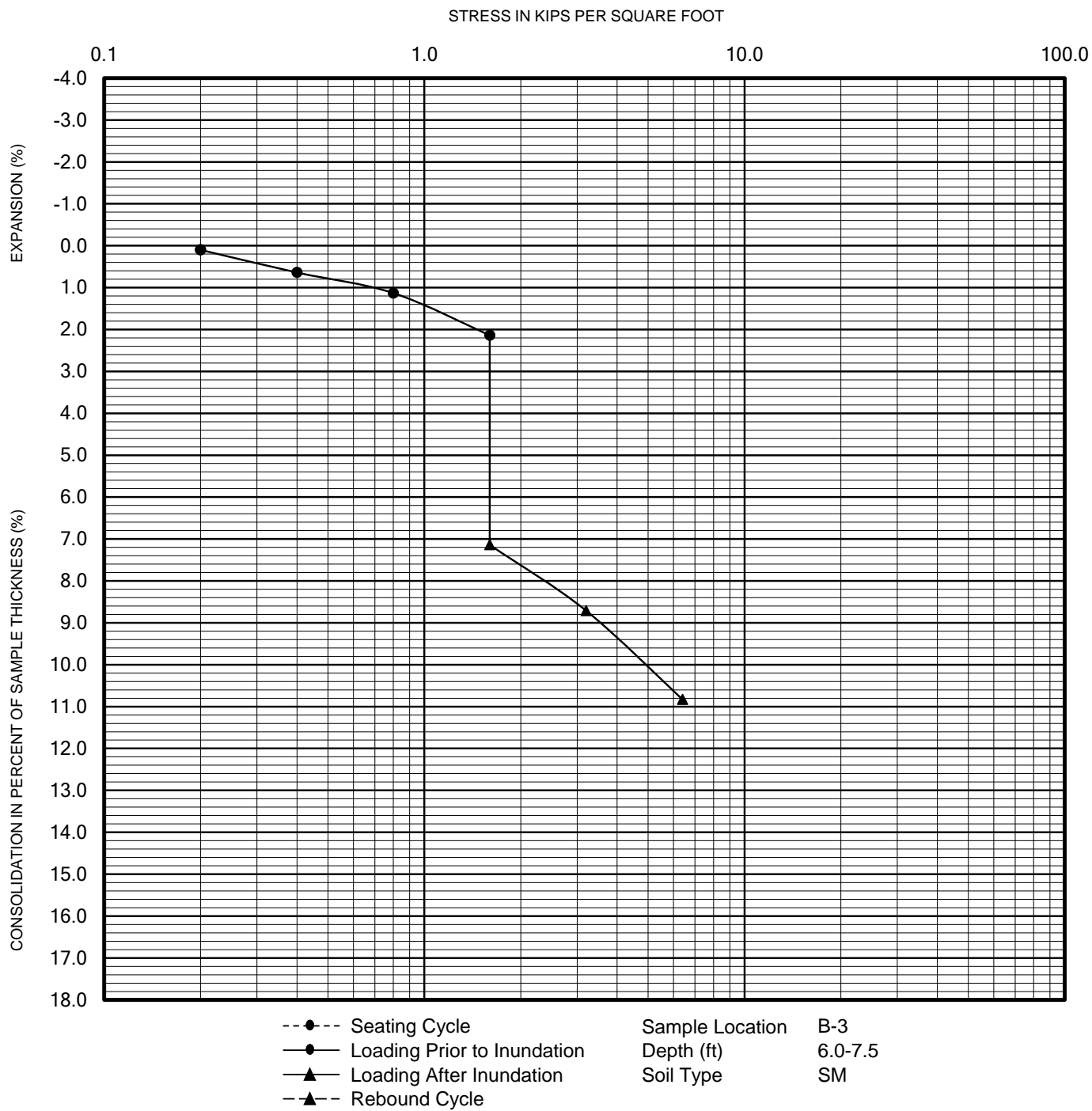
FIGURE B-18

CONSOLIDATION TEST RESULTS

RANCHO VISTOSO PARCEL 5-R

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PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2435

FIGURE B-19

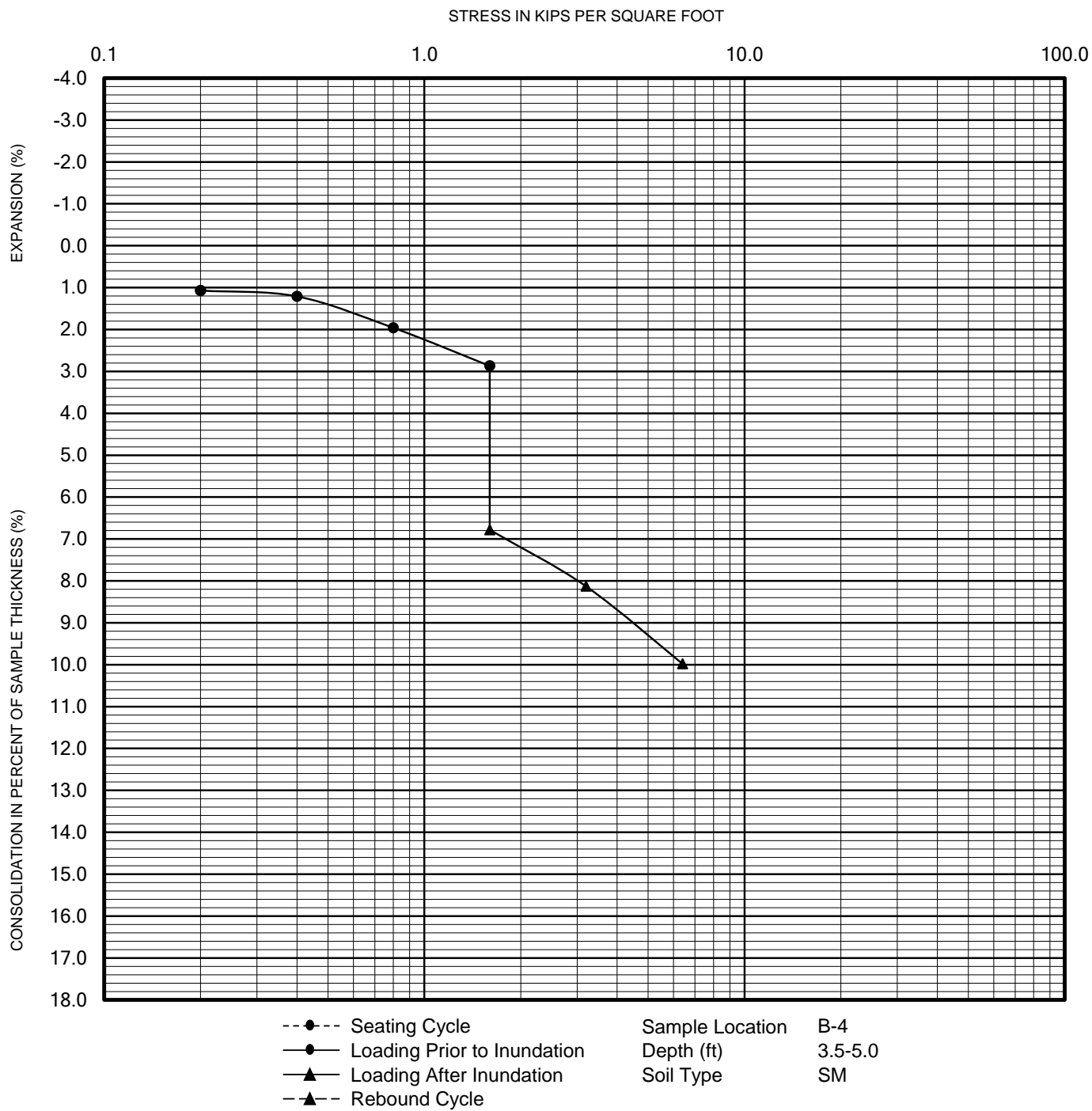
CONSOLIDATION TEST RESULTS

RANCHO VISTOSO PARCEL 5-R

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PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2435

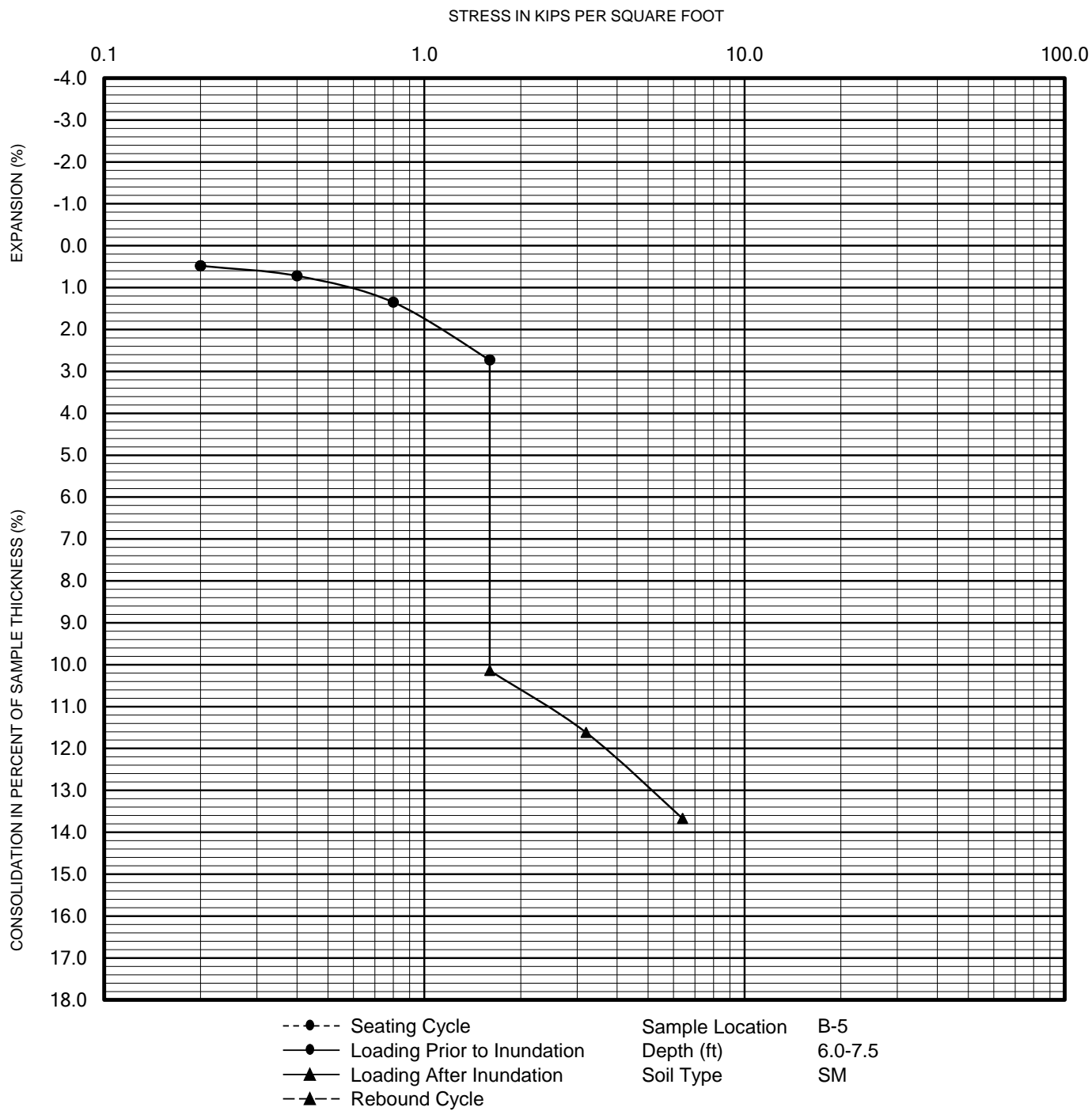
FIGURE B-20

CONSOLIDATION TEST RESULTS

RANCHO VISTOSO PARCEL 5-R

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PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2435

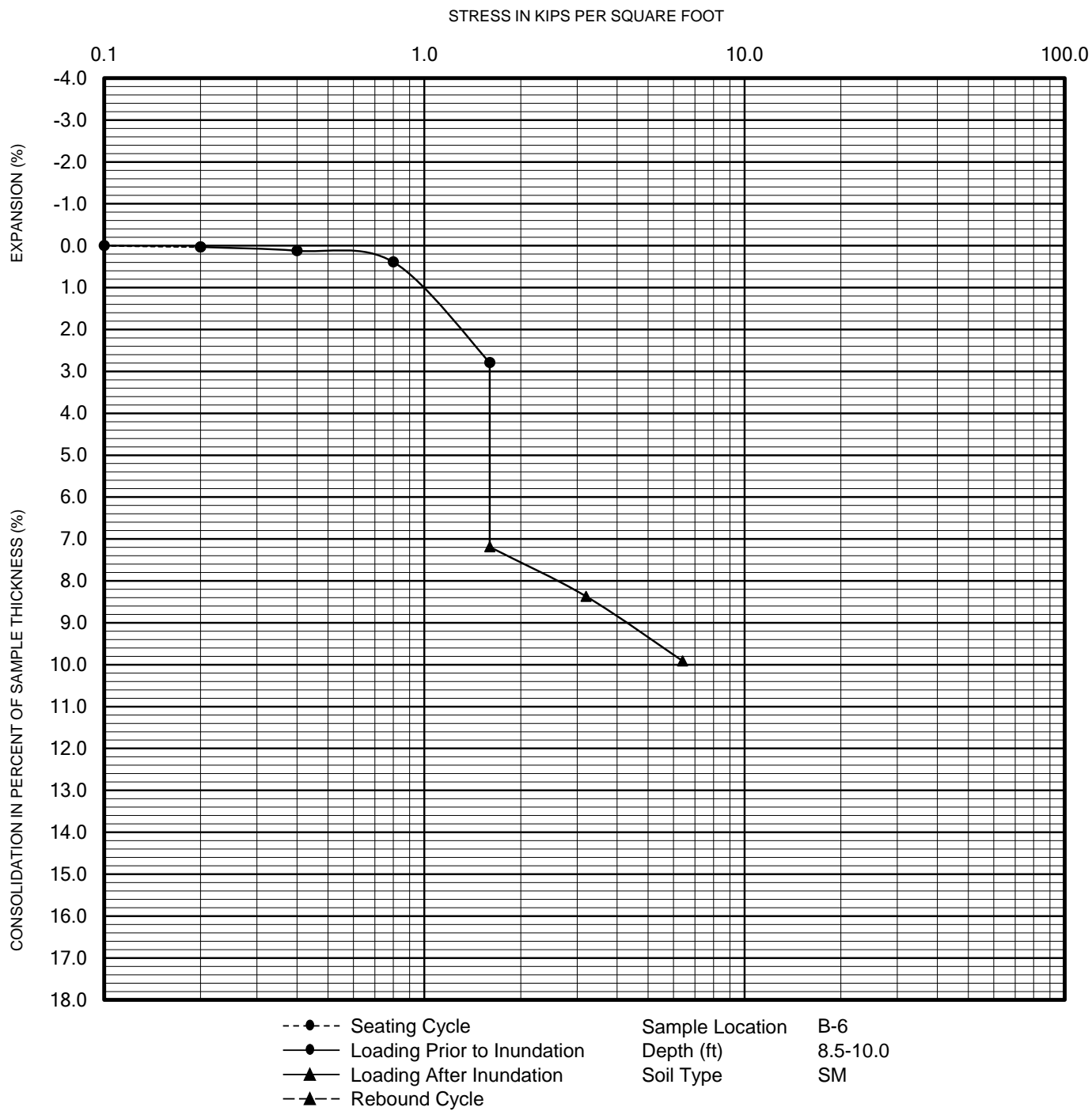
FIGURE B-21

CONSOLIDATION TEST RESULTS

RANCHO VISTOSO PARCEL 5-R

ORO VALLEY, ARIZONA

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PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2435

FIGURE B-22

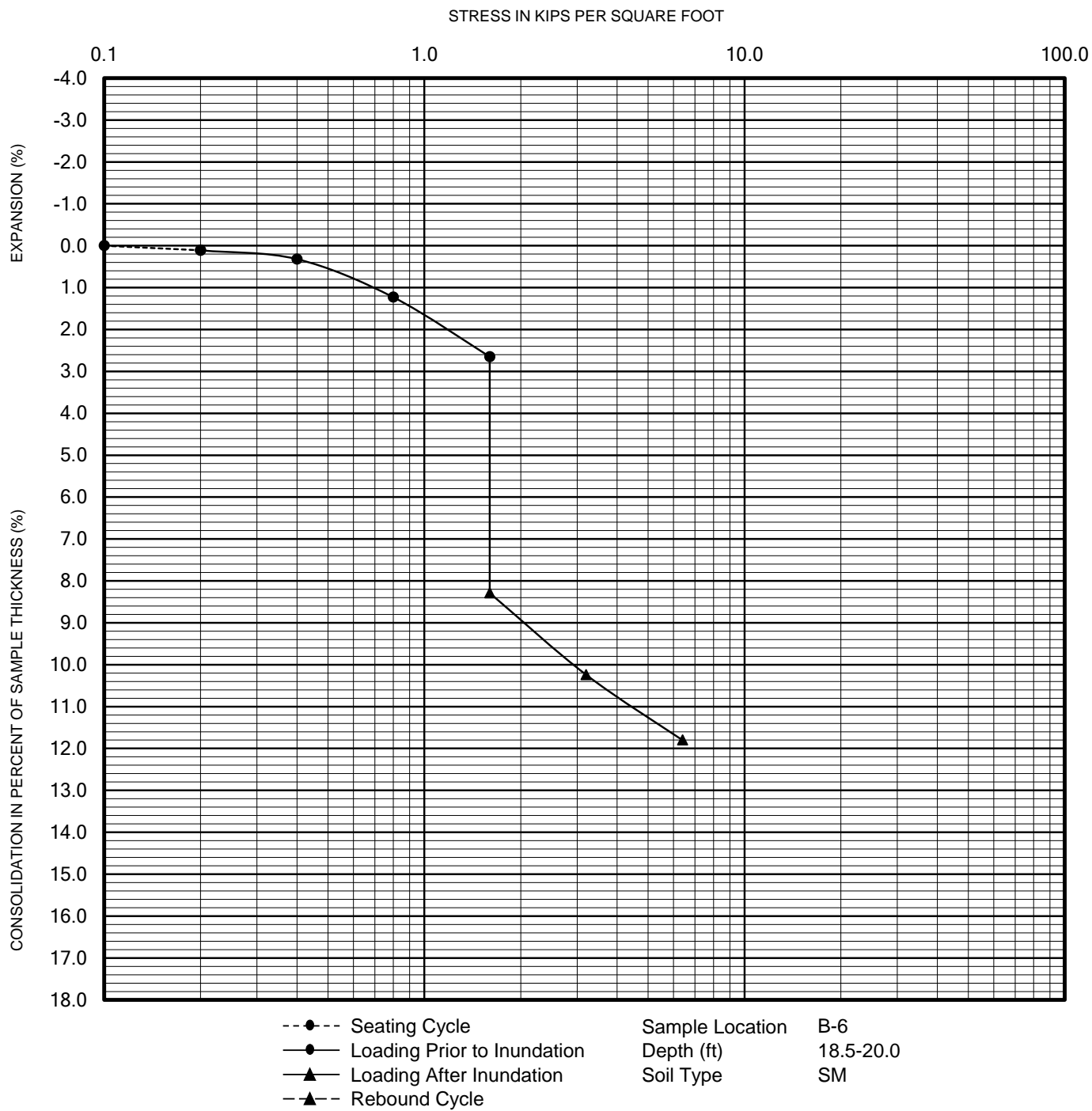
CONSOLIDATION TEST RESULTS

RANCHO VISTOSO PARCEL 5-R

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PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2435

FIGURE B-23

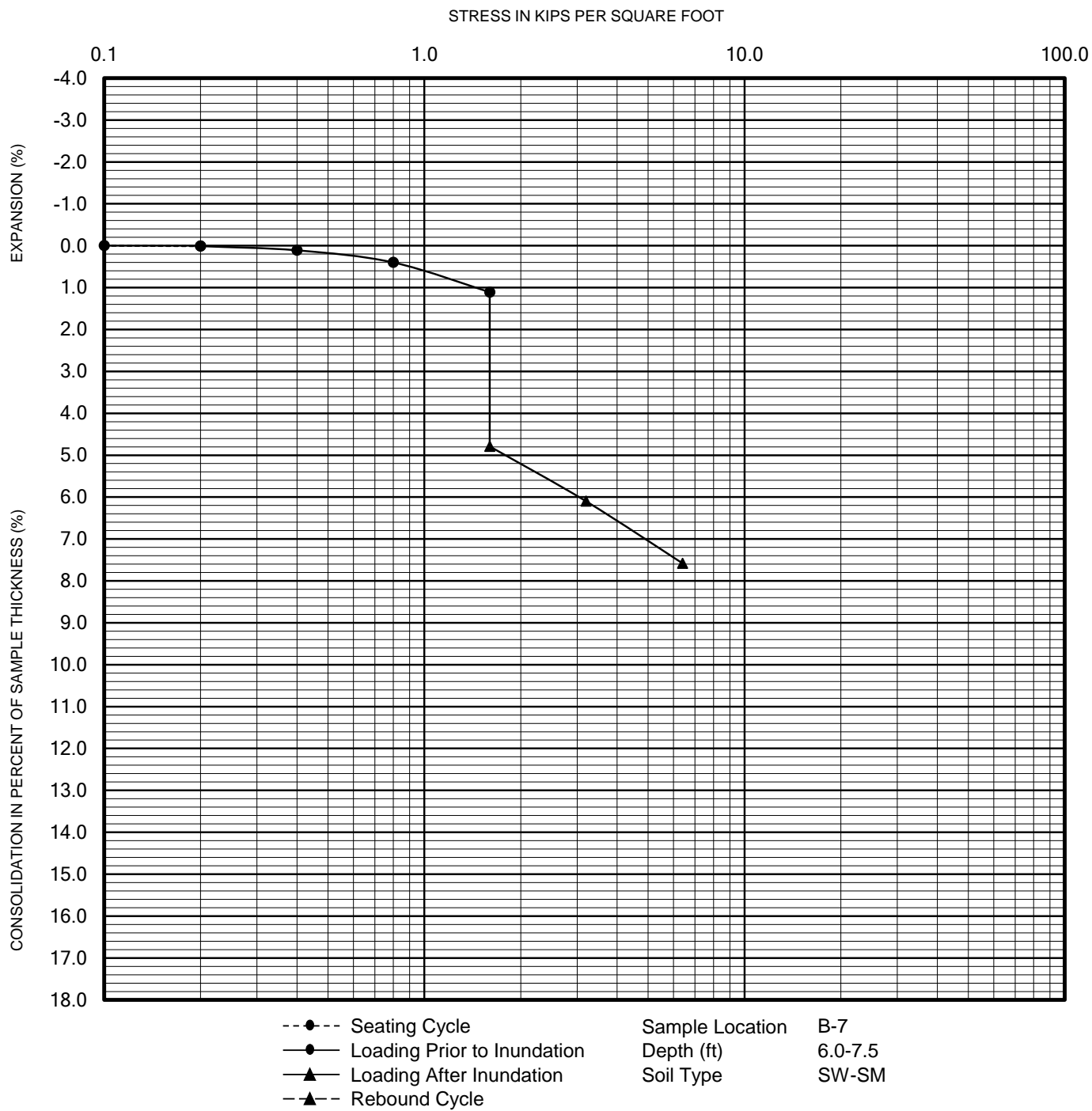
CONSOLIDATION TEST RESULTS

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PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2435

FIGURE B-24

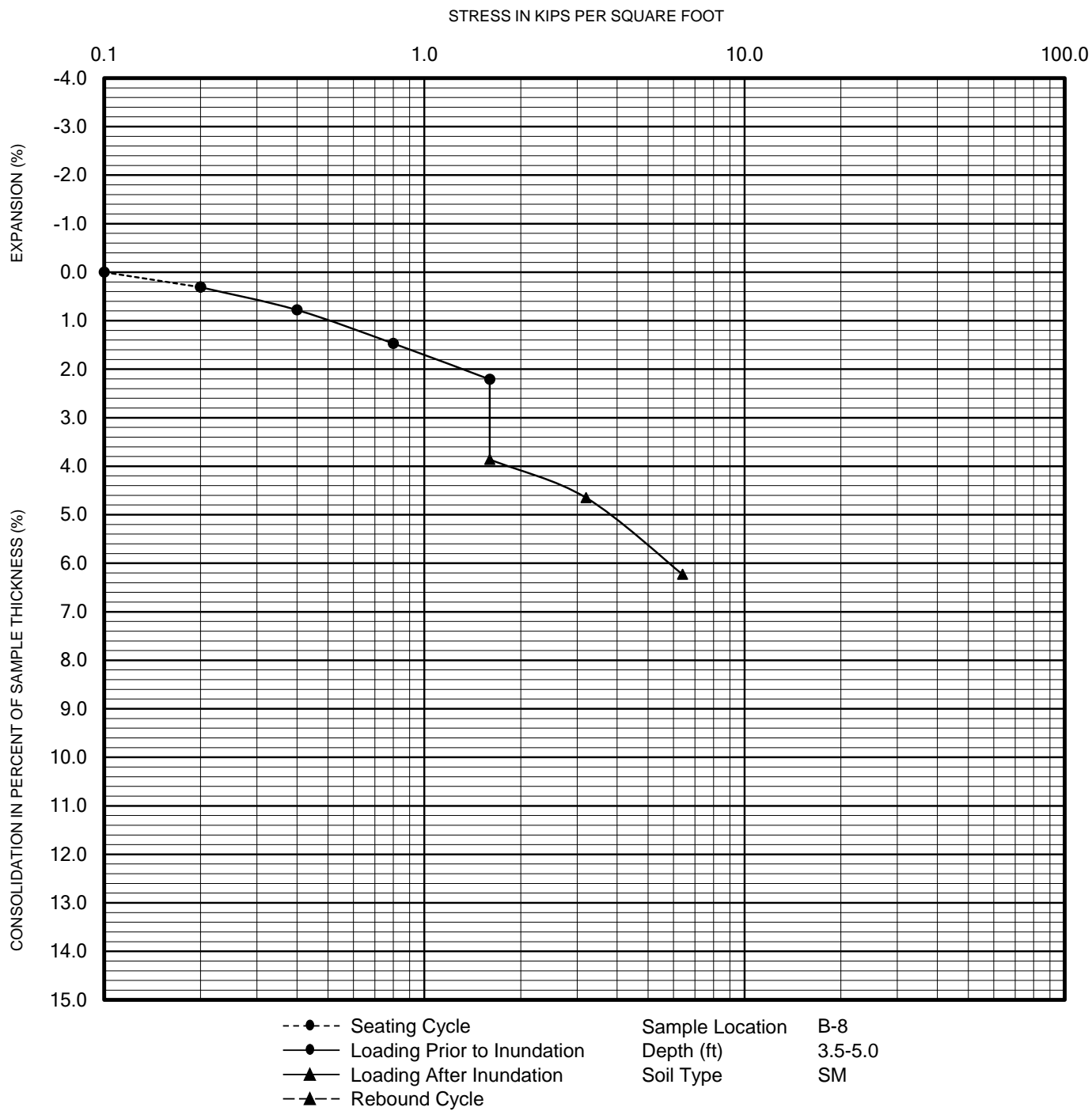
CONSOLIDATION TEST RESULTS

RANCHO VISTOSO PARCEL 5-R

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PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2435

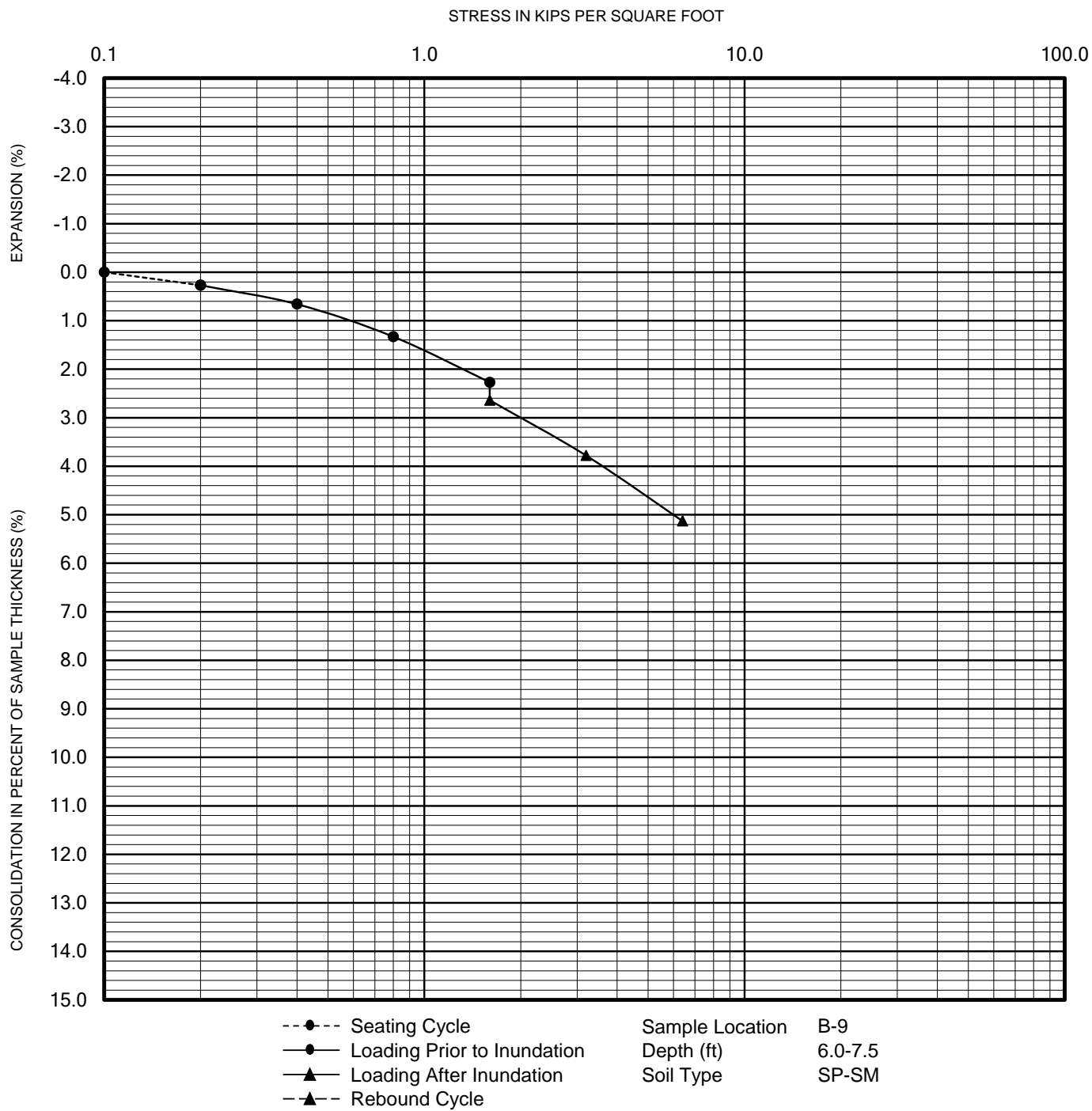
FIGURE B-25

CONSOLIDATION TEST RESULTS

RANCHO VISTOSO PARCEL 5-R

ORO VALLEY, ARIZONA

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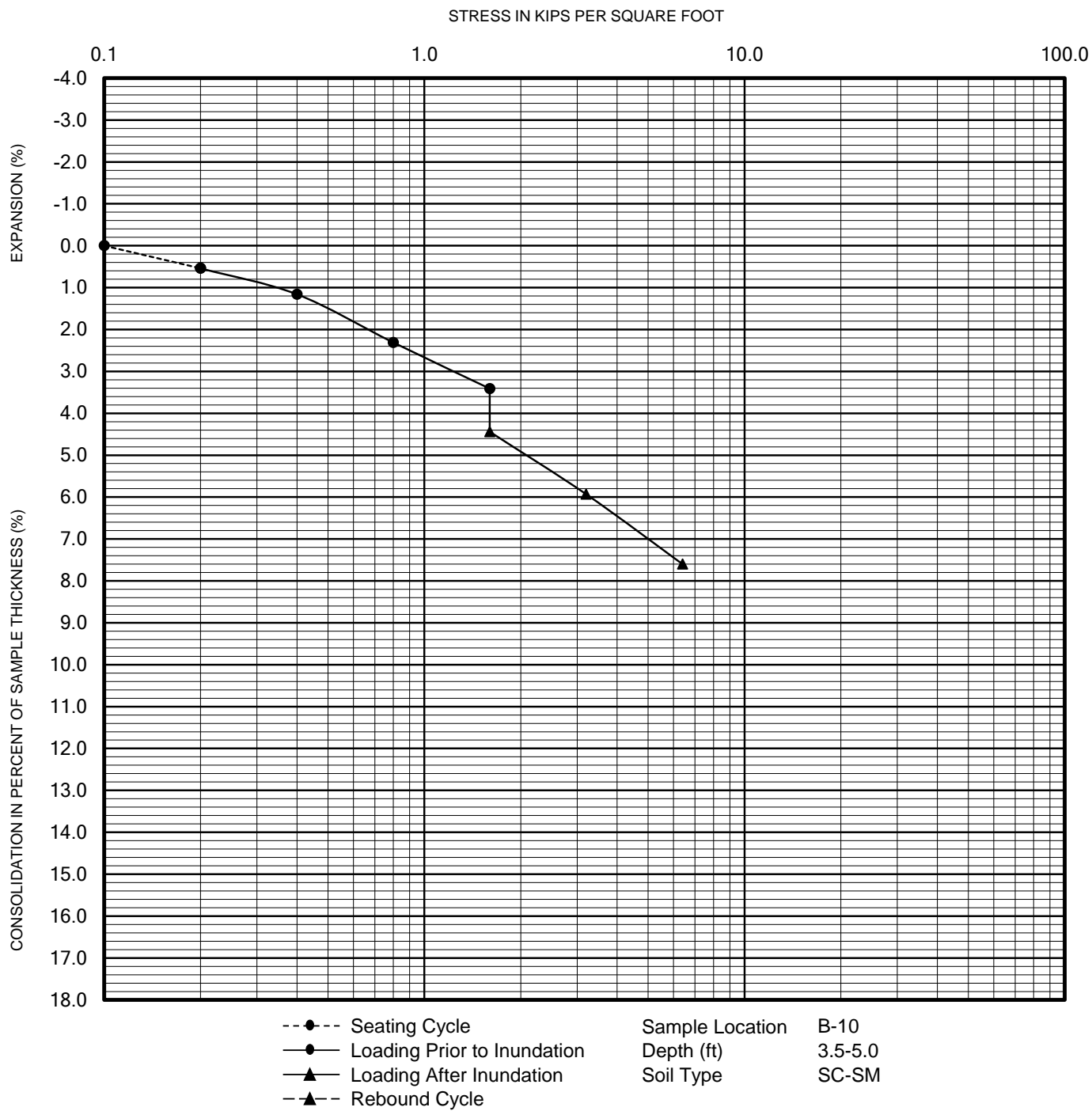
FIGURE B-26

CONSOLIDATION TEST RESULTS

RANCHO VISTOSO PARCEL 5-R

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FIGURE B-27

CONSOLIDATION TEST RESULTS

RANCHO VISTOSO PARCEL 5-R

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SAMPLE LOCATION	SAMPLE DEPTH (ft)	pH ¹	RESISTIVITY ¹ (Ohm-cm)	SULFATE CONTENT ² (ppm) (%)		CHLORIDE CONTENT ³ (ppm)
B-1	0.0-5.0	8.2	10,050	50	0.005	10
B-3	0.0-5.0	8.1	2,615	50	0.005	11
B-5	0.0-5.0	8.1	6,030	50	0.005	17

¹ PERFORMED IN GENERAL ACCORDANCE WITH ARIZONA TEST METHOD 236c

² PERFORMED IN GENERAL ACCORDANCE WITH ARIZONA TEST METHOD 733

³ PERFORMED IN GENERAL ACCORDANCE WITH ARIZONA TEST METHOD 736

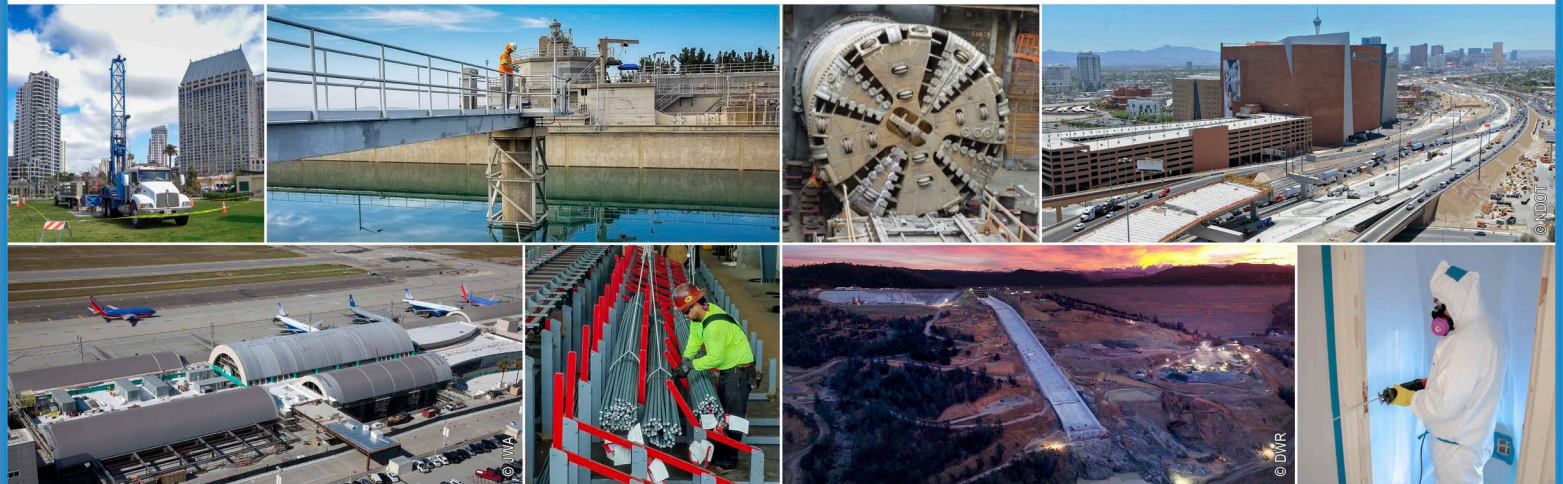
FIGURE B-28

CORROSIVITY TEST RESULTS

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