Geotechnical Engineering Study

Bird Avenue 18-Inch Gravity Sewer Replacement
El Paso, El Paso County, Texas
LOI File No. 21-137

Prepared for:
Huitt-Zollars, Inc.
5822 Cromo Drive, Suite 210
El Paso, Texas 79912

Prepared by:
LOI ENGINEERS
2101 E. Missouri Avenue, Suite B
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Initial Draft issued July 22, 2021
Final Report issued August 3, 2021

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File No. LOI21-137
July 22, 2021 (Final 8/3/2021)

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Mr. Floyd Johnson, P.E.
Huitt-Zollars, Inc.
5822 Cromo Drive, Suite 210
El Paso, Texas 79912

Re: Geotechnical Engineering Report
Bird Avenue 18-Inch Gravity Sewer Replacement
El Paso, El Paso County, Texas

Dear Mr. Johnson:

We thank you for the opportunity to present the enclosed geotechnical engineering report for the above referenced project. This engineering report was prepared in accordance with the scope of services as presented in our proposal No. LOIP21-143, dated March 9, 2021, and authorized on April 30, 2021. The information we are presenting herein describes the procedures utilized for field and laboratory investigation, along with the results of our study.

It was a pleasure to work with you on this phase of your project, and we look forward to assist you further during the subsequent construction activities. If you have any questions regarding the information we present herein, please call us.

Respectfully submitted,
LOI ENGINEERS

Geoffrey A. Madrazo, P.E.
Project Professional

Bernardino Olague, P.E.
Principal Engineer

STATE OF TEXAS
Bernardino Olague
81628
LICENSED
PROFESSIONAL ENGINEER
8/3/2021

Copies: Above (1), Email (1)
File

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1.0 INTRODUCTION

We have completed the geotechnical engineering study for the proposed Bird Avenue 18-inch Gravity Sewer Replacement project, which will be located in El Paso, Texas. We were authorized to conduct this study by Ms. Isabel Vasquez, P.E., representing Huitt-Zollars, Inc. (Client) on April 30, 2021.

2.0 PROJECT DESCRIPTION AND OBJECTIVE

The project consists of the design and construction of a new 15-inch diameter gravity sewer system to replace an 18-inch gravity sewer system, which will be abandoned in-place. The new gravity sewer system will include about 2,550 linear feet (LF) of 12-inch diameter PVC sewer pipe (main line), about 140 LF of 8-inch diameter PVC sewer pipe (tie-in connections), nine (9) manhole structures, and about 3,900 square yards of flexible pavement replacement, including cement stabilized backfill. The pipeline will have invert elevations ranging from 3722.35 feet to 3733.21 feet above MSL. The proposed sewer alignment will parallel Bird Avenue, beginning about 20 feet to the west of River Bend Drive, and ending about 160 feet to the west of Doniphan Drive, in the upper valley of El Paso, El Paso County, Texas, as shown on the General Location Map in Appendix A (Sheet A-1.1).

We conducted our study in general accordance with the "Recommended Practice for the Design of Foundations" manual published by the American Society of Civil Engineers.

3.0 FIELD AND LABORATORY INVESTIGATION

3.1 Field Exploration

In our field exploration phase, we drilled and sampled five (5) soil borings to depths of 20 feet and 21½ feet, respectively, below ground surface at representative locations along the proposed 12-inch sewer line. We drilled and sampled the soil borings in general accordance with ASTM D-6151 and D-1586 procedures with a truck-mounted CME-75 drill

rig. We located the borings in the field using property corners and street references included in the project plans provided by Client.

The soil boring locations are shown in the Boring Location Plan included in Appendix A of this report in Sheet A-1.2. We also prepared a log of each soil boring to delineate the soil strata studied at the site. The soil boring logs (B-1 through B-5) are included in Appendix A of this report as Sheets A-2 through A-6. A key to the soil terminology used in the logs is included in Appendix B of this report as Sheets B-1 and B-2.

We conducted Standard Penetration Tests (SPT) at each representative soil strata in the soil borings to determine the relative density or consistency of the resident soils. The SPT is a widely recognized procedure that provides a numerical value of the soil strata being tested, indicating the number of blows that it takes for a standard 140-pound weight hammer with a standard 30-inch free fall drop to penetrate 12 inches into the soil. The SPT values for the soil strata in the soil borings are included in the soil boring logs.

As part of our field exploration, we collected representative soil samples from the soil borings at regular depth intervals using a standard 2-inch diameter split spoon sampler. We identified and labeled the samples according to boring number and depth, visually classified them according to ASTM D-2488, and placed them in moisture-proof containers for transportation to the laboratory for further evaluation and testing.

Unless we receive prompt notification from Client, we will store the samples collected from the field investigation in our laboratory for a period of 90 days from the date of this report, after which time we will discard the samples.

3.2 Geotechnical Laboratory Testing

In the laboratory, we determined the moisture content, particle size analysis, percent passing the No. 200 sieve, and Atterberg Limits of selected samples. We conducted these tests to determine the physical and engineering properties of representative soils at the site. These tests also allowed us to properly classify the resident soils in accordance with

the Unified Soil Classification System (USCS). The results of our tests are included in the soil boring logs, adjacent to the depth at which the sample was recovered.

In addition, we conducted four (4) soil moisture-density relationship tests and one (1) California bearing ratio (CBR) test, in accordance with ASTM D-1557 and D-1883, respectively. The results of these tests can be found on Sheets A-9 through A-13, respectively.

Table 1: Laboratory Testing Program

Type of Test	Number of Tests
Moisture Content (ASTM D-2216)	35
Percent Passing No. 200 Sieve (ASTM D-1140)	35
Grain Size Distribution Analysis (ASTM D-6913)	18
Atterberg Limits (ASTM D-4318)	15
California Bearing Ratio Test (ASTM D-1883)	1
Moisture-Density Relationship Curve (ASTM D-1557)	4

4.0 GENERAL SITE CONDITIONS

4.1 Site Geology

The project site is located on the Rio Grande flood plain. According to the Soil Conservation Service of El Paso County, the soils in this area correspond to the Harkey-Glendale association, which is described as nearly level soils that have loamy very fine sand to silty clay loam underlying material.

4.2 Site Topography and Site Conditions

The project site is relatively level, and generally slopes gently downward in a southerly direction. The proposed site is located within the right-of-way of Bird Avenue in El Paso, Texas. The site is topped with a hot-mix asphaltic concrete (flexible) pavement, ranging in thickness from 2½ inches to 4 inches. The existing pavement was underlain by about 6 inches of base course material. The southwest end of the proposed sewer line alignment extends beyond the pavement area.

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4.3 Site Vegetation

At the time of our field phase, the site exhibited moderate vegetation beyond the edge-of-pavement, consisting of weeds, shrubs, trees, and grasses.

4.4 Soil Stratigraphy

The soils we encountered in the borings can be grouped into five (5) generalized soil strata as follows:

Stratum A, consisting of brown sandy silts, was encountered from top of pavement elevation, and extended to a depth of 2½ feet below bottom of pavement section (BPS) in soil boring B-4. These soils were encountered at a stiff consistency, with an SPT value of 15 blows per foot of penetration. These soils were encountered at a moist condition, with a tested moisture content value of 13 percent, and a percent finer than the No. 200 sieve test result of 52 percent. These soils exhibited non-plastic characteristics. Soils in this stratum can be classified as ML in accordance with the USCS.

Stratum B, consisting of brown fine grained clayey and silty sands, was encountered from top of pavement elevation, and extended to depths ranging from 5 to 10 feet BPS in the soil borings. These soils were encountered at a very loose to medium dense relative density, with SPT values ranging from 2 to 23 blows per foot of penetration. These soils were encountered at a dry to moist condition, with tested moisture content values ranging from 5 to 32 percent, and percent finer than the No. 200 sieve test results ranging from 13 to 48 percent. These soils exhibited a maximum tested liquid limit of 28 and yielded a maximum plasticity index of 13. Soils in this stratum can be classified as SM and SC in accordance with the USCS.

Stratum C, consisting of brown/multi-color fine grained poorly-graded sands occasionally intermixed with traces to some silt, was encountered underlying the Stratum B soils in the soil borings, and extended to depths ranging from 15 to 21½ feet BPS in the soil borings. These soils were encountered at a very loose to medium dense relative density, with SPT values ranging from 2 to 12 blows per foot of penetration. These soils were encountered

at a dry to saturated condition, with tested moisture content values ranging from 7 to 35 percent, and percent finer than the No. 200 sieve test results ranging from 2 to 11 percent. These soils exhibited non-plastic characteristics. Soils in this stratum can be classified as SP and SP-SM in accordance with the USCS.

Stratum D, consisting of brown fine grained clayey and silty sands, was encountered underlying the Stratum C soils in soil borings B-2 and B-5, and extended to depths ranging from 20 to 21½ feet BPS. These soils were encountered at a saturated condition, with tested moisture content values ranging from 26 to 30 percent, and percent finer than the No. 200 sieve test results ranging from 14 to 18 percent. These soils exhibited a maximum tested liquid limit of 21 and yielded a maximum plasticity index of 5. Soils in this stratum can be classified as SM and SC-SM in accordance with the USCS.

Stratum E, consisting of brown well-graded gravels intermixed with sand, was encountered underlying the Stratum D soils in soil boring B-5, and extended to the total explored depth of 21½ feet BPS. These soils were encountered at a medium dense relative density, with an SPT value of 27 blows per foot of penetration. These soils were encountered at a dry to moist condition, with a tested moisture content value of 8 percent, and a percent finer than the No. 200 sieve test result of 4 percent. Soils in this stratum can be classified as GW in accordance with the USCS.

4.5 Groundwater

Groundwater was encountered in the soil borings performed at the site during the time of our field exploration, which took place on June 29 and 30, 2021. The groundwater table at the site was encountered at depths ranging 7½ feet to 10 feet below top of pavement.

It is our opinion that the depth to groundwater at the site may vary considerably after periods of significant rainfall or during irrigation seasons. Fluctuations in groundwater may also occur as a function of temperature, groundwater withdrawal, and future construction activities that may alter the surface drainage and sub-drainage characteristics of the site.

5.0 ENGINEERING EVALUATION

5.1 Structural Information

Based on our experience with similar projects, we have assumed the total load of the manhole structures will be on the order of 50 tons or less, and structures will be precast or supported on mat foundations. If the final loads differ significantly from the assumed values presented herein, LOI ENGINEERS should be notified immediately so that we may conduct further analysis to determine whether our recommendations need to be revised, as appropriate.

5.2 Vertical Movements

We calculated the Potential Vertical Rise (PVR) of the existing soil profile from our soil borings in accordance with Texas Department of Transportation (TxDOT) method Tex 124-E. The soils encountered in our borings exhibited relatively low plasticity characteristics. The calculated PVR of the existing soil conditions is less than ¼-inch.

5.3 Site Preparation

The existing flexible pavement in the subject area, as well as any vegetation, shall be removed and properly disposed of off-site per applicable local regulations prior to grading operations. Soils at their present condition may provide adequate support for foundations, flatwork, and/or pavement sections when properly processed, moisture conditioned, and compacted as indicated in this report, provided that the appropriate dewatering measures are taken into consideration prior to preparing the soils. For structural elements and pipe invert elevations at least 2½ feet above the water table, the upper 24 inches of existing subgrade and/or select fill shall be moisture conditioned to within ±3% of its optimum moisture content and compacted to at least 95% of its maximum dry density, as determined by ASTM D-1557.

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5.4 Foundation Recommendations

The proposed manhole structures may be supported on individual spread foundation systems. Allowable soil bearing capacities and design parameters for foundations considering hydrostatic pore pressures are presented in the following table:

Table 2: Foundation Recommendations

Type of Foundation	Allowable Soil Bearing Capacity (lb/ft^2)	Minimum Footing Width (in.)	Minimum Footing Bearing Depth (in.)	Minimum Select Fill Below Bottom of Footing Elevation (in.)
Above Water Table				
Individual Spread	1,800	24	18	24
Continuous	1,700	24	18	24
Below Water Table[1,2]				
Individual Spread	900	24	18	24
Continuous	850	24	18	24

[1]Recommended values considering hydrostatic pressure below the water table.

[2]Select fill placement for foundations below the water table can be substituted with 18 inches of controlled density fill material (minimum 2-sack mix).

The horizontal limits of over excavation shall extend 24 inches beyond the footing line.

Foundation systems designed and constructed based on the above data and parameters should experience total settlement of less than one inch. It is very important to provide adequate drainage to eliminate water accumulation or infiltration near the proposed building. Based on our settlement calculations using Schmertmann's method total settlements were estimated at 1-inch for a time equal to 1 year (T=1yr.).

Although differential settlement is typically estimated to be about one-half the total settlement (Ds=½-inch), differential movements across foundations may approach the total settlement if loose or soft soil deposits are left within the foundation footprints. The foundation system to be designed in accordance with the above criteria considers a safety factor of 3. Floor slabs should also be supported on select fill as recommended in Section 5.6 of this report.

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5.5 Trench Guidelines

We recommend adequate protection on the faces of the excavations to prevent hazards from falling material. Adequate sloping on the faces of the excavations should also be implemented to avoid possible soil sloughing.

The Occupational Safety and Health Administration (OSHA) classifies soils for the purpose of defining stable slopes to be used in trenching applications.

The soils found during our field exploration, are considered Type C materials. For temporary slopes in soil trenching for this project, Type C soils can have a maximum slope of 1½:1 (H:V).

The contractor may be required to utilize shielded trench systems during the construction phase whenever excavations deeper than 5 feet are required taking into consideration site constraints such as vehicular traffic, existing underground lines (fuel, natural gas, telecommunication, and water), overhead lines, and existing structures.

We should note that the information included in this report is for design purposes, and is not intended to provide a trench safety plan. The contractor should develop a trench safety plan in accordance with the requirements of OSHA and specifications in the project plans. If trench shields will be used, these should be selected appropriately to retain the lateral loads from the native coarse grained soils.

5.6 Manhole Structures

Flatwork (i.e. individual spread footings or rigid mats) for the proposed manhole structures should be built on a minimum of 24 inches of compacted select fill material or suitable subgrade soils. Select fill placement below the water table can be substituted with 18 inches of controlled density fill material (minimum 2-sack mix). A modulus of subgrade reaction of 200 pounds per cubic inch may be used for backfill materials in the design of floor slabs.

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5.7 Lateral Earth Pressures

We recommend the following values to be used in earth pressure computations, considering the Rankine method for lateral earth pressure computation having cohesionless or granular native materials as follows:

$$\Phi = 28°$$

$$\gamma_w = 120 \text{ lb/ft}^3$$

Additionally, the equivalent fluid density, considering the equivalent fluid method with the appropriate k value, may be computed as follows:

$$G_h = k^*\gamma_w$$

For concrete or masonry walls, the wall-soil interface friction angle may be computed as follows:

$$\Phi_w = 0.67\Phi$$

Coefficients of active and passive earth pressure are given below, along with the coefficient for the possible at-rest condition:

$$k_a = 0.36$$

$$k_p = 2.77$$

$$k_o = 0.53$$

5.8 Groundwater Control

Relatively shallow groundwater was encountered at the site and may be encountered in excavations at the site. If encountered, we recommend that the groundwater table be lowered and maintained at a depth of at least 2 feet below excavation levels during construction. Adequate control of the groundwater could possibly be accomplished by means of pumping from temporary gravel-lined, cased sumps. However, due to a relatively high permeability of some of the sand layers, cased sumps may not offer

enough relief and positive groundwater control such as cased wells or a well point system may be required. The actual system that is to be used can likely best be determined at the time of construction. Whichever system is used, it should offer some flexibility and should operate continuously during the below grade construction process.

Groundwater control should be the responsibility of the contractor. The contractor should be required to submit a dewatering plan. Details of the contractor's design and the contractor's planned approach should be addressed in this plan to assure every effort is being made to effectively lower the groundwater. It may be prudent to require the submittal of the dewatering plan as part of the bidding process to help preclude the possibility that the apparent low bidder has inappropriately addressed any significant items in the construction. It may become difficult to require the contractor to adequately address dewatering as part of the actual construction process after the project has been awarded.

The contractor should be prepared to promptly remove surface water from the general construction area by ditching or other means.

5.9 Buoyancy

The proposed manhole structures will be founded at depths of 8 feet or greater below the existing grade. These structures will experience uplift loads in the event of groundwater fluctuations. The manholes should perform satisfactorily if a design factor of safety against uplift of 2.0 is used. In an open cut installation technique, the foundation for the manholes may be extended beyond the wall line to create a toe extension to provide sufficient weight of overburden soil to resist hydrostatic uplift at the bottom of the structures. Only the submerged weight of the soils mass directly above the toe extension and the dead weight of structure should be considered when calculating the uplift resistance. An alternative to foundation toe extension would be to increase the mass of the manhole structures. A submerged unit weight of 60 pounds per cubic foot can be used to compute the resistance to uplift loads.

5.10 Site Drainage

Positive surface drainage should be provided during and after construction by sloping the ground surface a minimum of two percent graded away from the structures for a minimum distance of 5 feet. Irrigated planters should not be allowed adjacent to the structures. Underground water and sewer lines should be properly installed underneath the structures to reduce the possibility of moisture infiltration in the event of plumbing leaks.

5.11 Seismic Considerations

Table 3: Seismic Design Parameters (2015 International Building Code)

Parameter	Value
Site Class	D
Site Location (latitude, longitude)	31.825381, -106.574157
S_{MS} – Spectral Response Acceleration for Short Periods	0.475g
S_{M1} – Spectral Response Acceleration for a 1-Second Period	0.226g
S_{DS} – Design Spectral Response Acceleration for Short Periods	0.316g
S_{D1} – Design Spectral Response Acceleration for a 1-Second Period	0.151g

5.12 Flexible Pavement Recommendations

Flexible pavements will be used in the reconstruction of the roadway after the sewer line installation. Therefore, we used a traffic loading of 630,000 equivalent single-axle load (ESAL) applications for areas that will be subjected to heavy traffic loads. This parameter is estimated based on the intended usage and estimated automobile traffic for a design period of 20 years. Additionally, based on our laboratory analysis we calculated a California Bearing Ratio (CBR) value of 33 for pavement design calculations.

We recommend that the flexible pavement consists of the following minimum thickness section for light duty and heavy duty traffic conditions:

Table 4: Flexible Pavement Recommendations

Pavement Component	Heavy Duty Traffic Minimum Thickness (in.)
Hot-Mix Asphaltic Concrete	3
Crushed Stone Base Course	8
Compacted Subgrade	12

As a minimum, the HMAC material should conform to Type C, in accordance with the City of El Paso standards. The HMAC mix should have a minimum 1,500 pounds of Marshall Stability when compacted at 75 blows in accordance with ASTM D-1559, and should have a flow between 8 and 16. The HMAC course should be placed at a target density of at least 98 percent.

The Crushed Stone Base Course (CSBC) should be Item 247, Type A, Grade 3 in accordance with the Texas Department of Transportation (TXDOT) Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges. CSBC materials should be placed in loose lifts not exceeding 6 inches in compacted thickness, and compacted to a minimum 95 percent of maximum dry density and a moisture content within plus or minus 2 percent, in accordance with ASTM D-1557.

5.13 Select Fill

Select fill material used for site grading should be granular, cohesionless, and free of deleterious material and particles over 4 inches in greatest dimension. Soils proposed for use as fill materials should be classified in accordance with ASTM D-2487. The following soils classified in accordance with the Unified Soil Classification System (USCS) can be considered satisfactory for use as select fill.

> GM, GC, GW-GM, GW-GC, GP, GP-GM and GP-GC, SM, SC, SW-SM, SW-SC, SP-SM, SW-SC and SC-SM.

The following USCS-classified soils are not considered satisfactory for use as select fill.

> CH, CL, MH, ML, OH, OL and PT, or soils that exceed a liquid limit of 40 and a plasticity index of 15.

The Stratum A soils in our borings are NOT suitable for use as select fill. All other soils encountered in our soils borings are suitable for use as select fill, provided they meet the above criteria for acceptable fill materials.

Select fill should be placed in uniform layers not exceeding 8 inches in compacted thickness, moisture-conditioned to add the amount of moisture required for optimum compaction and compacted to a minimum of 95 percent of maximum density in accordance with ASTM D-1557 (modified Proctor) procedures. The moisture content should be at plus or minus 3 percent of optimum moisture content in accordance with ASTM D-1557.

This compaction requirement also applies to the subgrade soils that will receive select fill. However, if the subgrade soils consist of cohesive soils such as CL or CH, or if the plasticity index exceeds 18, the subgrade soils should be compacted to a minimum of 90 percent of the above standard.

Compaction of the fill material and subgrade soils should be conducted with approved types of pneumatic, power or tamping equipment. Determination of density in the field should be conducted in accordance with ASTM D-2922 or D-1556.

5.14 Pipe Bedding and Trench Backfill

Pipe bedding and backfill material should be placed in uniform layers not exceeding 8 inches in compacted thickness, moisture conditioned to add the amount of moisture required for optimum compaction, and compacted to a minimum of 95 percent of maximum density in accordance with ASTM D-1557 (modified Proctor) procedures. Soil moisture content should be at plus or minus 3 percent of the optimum moisture content in accordance with the above standard. Refer to Appendix C for El Paso Water Standard Details for bedding and backfill of pressure pipe and gravity pipe in dry and wet conditions. Use the following soil types for the standard details in Appendix C.

Table 5: Pipe Bedding Recommendations

Soil Class	Soil Type ASTM D 2487	Soil Description
Class I	None	Manufactured aggregates, angular, crushed rock, crushed gravel with maximum particle size of 1½ inches per ASTM D-2321
Class II	GW, GP, SW, SP	Coarse grained sands and gravels per ASTM D 2487 with maximum particle size of 1½ inches per ASTM D-2322
Class III	GM, GC, SM, SC	Coarse grained sands with fines per ASTM D 2487 with maximum particle size of 1½ inches per ASTM D-2323

5.15 New Construction near Existing Structures and Utilities

Contractor shall exercise extreme care during excavation and site preparation near existing manhole structures, utility poles, trees, and residential structures, to avoid encroaching into the existing bearing soils, hence preventing adversely affecting or undermining the performance and structural integrity. We also recommend that before any excavation or earthwork takes place, all underground utilities be located to prevent damages to the existing infrastructure. We also recommend that any underground utilities that may encroach the proposed sewer line be decommissioned, removed and/or relocated, and the voids need to be filled with select fill as recommended in Section 5.12 of this report.

We recommend that ten (10) days prior to commencing any excavation near the existing building, the contractor shall submit a plan describing how they will protect the existing structures during construction activities. Protective measures may include, but may not be limited to temporary shoring and/or phased excavation.

6.0 ADDITIONAL CONSIDERATIONS

6.1 Construction Monitoring

We recommend that Client retain LOI ENGINEERS during the construction phase of this project to verify the findings of our study, and to provide supplemental data to this study in the event that site conditions vary from those described in this report.

The geotechnical engineer should also conduct testing of fill materials used for earthwork operations at the following frequencies:

- At least one (1) moisture-density relationship (ASTM D-1557) and soil classification tests (ASTM D-6913 and ASTM D-4318) for each type of material encountered, or imported material to be used.
- Soil density (compaction) testing in accordance with ASTM D-6938 or D-1556 using the following testing frequencies:
    - Manhole pad – A minimum of one (1) density test per lift (8-inch compacted) for every 1,000 square feet.
    - Pipe area – A minimum of one (1) density test per lift (8-inch compacted) for every 200 linear feet for pipe bedding and backfill operations, or at least three (3) tests per lift, whichever is greater.
    - Pavement area – A minimum of one (1) density test per lift (8-inch compacted) for every 2,000 square feet.

Sampling and testing for quality assurance of concrete materials should be performed at the following frequency:

- A minimum of one (1) set of four specimens should be collected for every 50 cubic yards of concrete placed, or fraction thereof. Concrete field testing shall include temperature, slump, and air content (if applicable).

Sampling and testing for quality assurance of asphaltic concrete materials should be performed at the following frequencies:

- A minimum of one (1) hot-mix asphaltic concrete (HMAC) analysis, to include Marshall test, Rice test, asphalt content and gradation, and Marshall flow and stability, for every 500 tons of HMAC material.
- A minimum of one (1) nuclear density test in accordance with ASTM D-2950 for every 2,000 square feet.

6.2 Limitations

We have performed our professional services and have obtained the data presented in this report in accordance with generally accepted geotechnical engineering principles

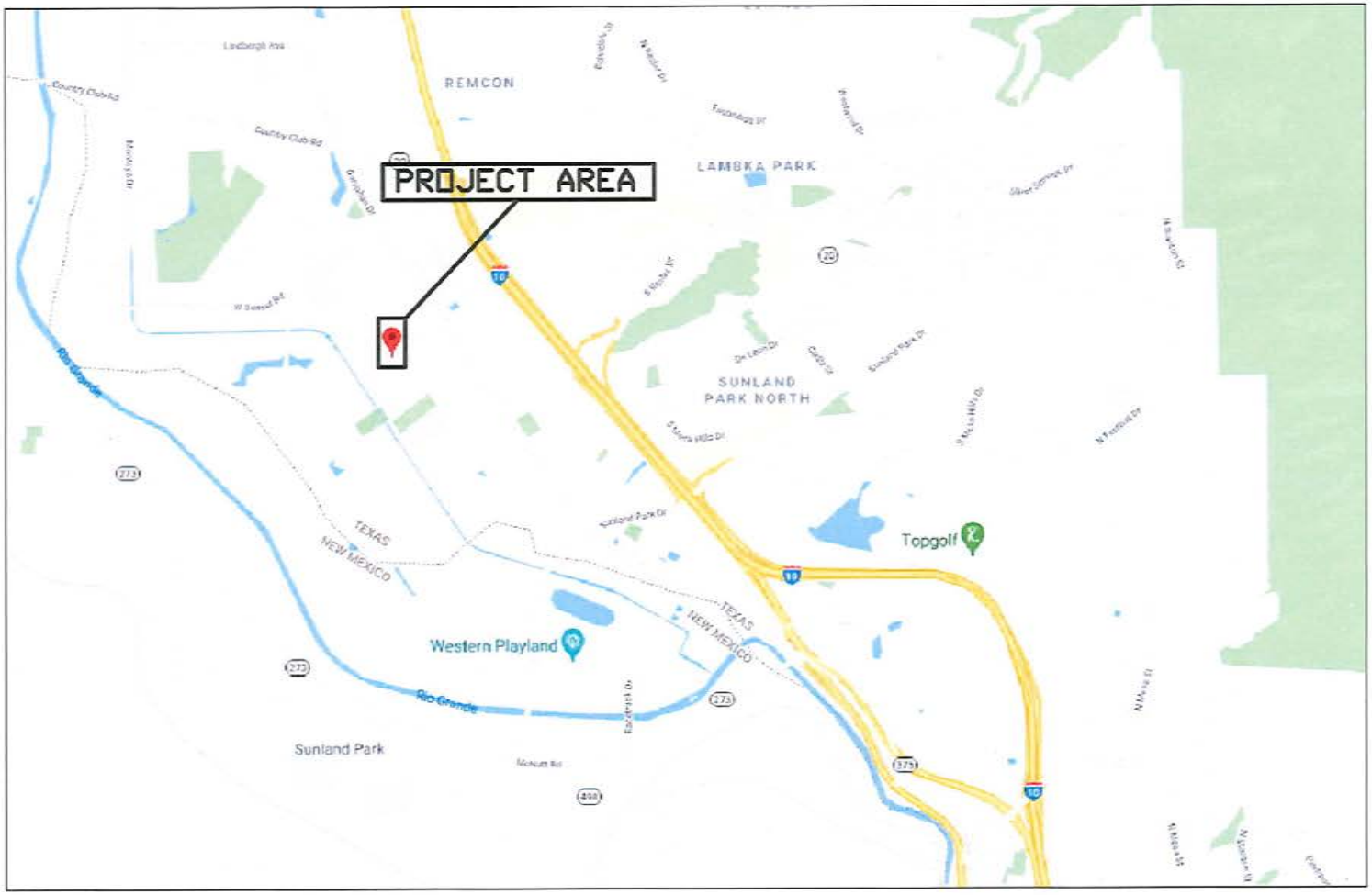
and practices. The information in this report is based on the data obtained from five (5) representative test borings and laboratory testing conducted on representative samples, and on our knowledge of the project conditions at the time of our subsurface soil study.

The data in this report reflects subsurface soil conditions only at the specific sampling location, time of sampling, and to the depths indicated in our report. This report is not intended to identify or address any potential environmental concerns associated with the project site.

We recommend that Client notify LOI ENGINEERS of any changes to the project conditions considered in this report, so that we may provide pertinent modifications to our recommendations if deemed necessary. Additionally, once construction commences, we should be notified of any unusual site conditions that appear to vary from those reported herein, so that we may conduct further investigations and prepare supplemental recommendations if deemed necessary.

We conducted this investigation for the purpose of defining the subsurface soil conditions for the Bird Avenue 18-Inch Gravity Sewer Replacement project, in El Paso, Texas. Use of this information for projects other than the one described herein will not be adequate.

APPENDIX A



LEGEND	GEOTECHNICAL CONSULTANT	PROJECT CONSULTANT	DRAWING TITLE: GENERAL LOCATION MAP
APPROXIMATE PROJECT LOCATION	LOI ENGINEERS 915-781-1532 2101 E. MISSOURI AVE SUITE B EL PASO, TEXAS 79903	HUITT-ZOLLARS, INC. 5822 CROMO DRIVE, SUITE 210 EL PASO, TEXAS 79912	PROJECT NAME: BIRD AVENUE 18-INCH GRAVITY SEWER REPLACEMENT EL PASO, EL PASO COUNTY, TEXAS

DRAWN BY	REVIEWED BY	APPROVED BY	SCALE
A.G.	G.M.	B.O.	N.T.S.
PROJECT No.	**FILE NAME**	**DATE**	**SHEET No.**
LOI21-137	SITE PLAN	06/30/21	A-1.1

LEGEND	GEOTECHNICAL CONSULTANT	PROJECT CONSULTANT	DRAWING TITLE: BORING LOCATION PLAN
B-1 APPROXIMATE BORING LOCATION AND NUMBER	LOI ENGINEERS 915-781-1532 2101 E. MISSOURI AVE SUITE B EL PASO, TEXAS 79903	HUITT-ZOLLARS, INC. 5822 CROMO DR., SUITE 210 EL PASO, TEXAS 79912	PROJECT NAME: BIRD AVENUE 18-INCH GRAVITY SEWER REPLACEMENT EL PASO, EL PASO COUNTY, TEXAS

DRAWN BY	REVIEWED BY	APPROVED BY	SCALE
A.G.	G.M.	B.O.	N.T.S.
PROJECT No.	**FILE NAME**	**DATE**	**SHEET No.**
LOI21-137	SITE PLAN	06/30/21	A-1.2

LOG OF TEST BORING No. B-1

Project name: Bird Avenue 18-Inch Gravity Sewer Replacement
File No.: LOI21-137
Date drilled: 06/29/21
Boring Location: See Sheet A-1.2
Elevation (ft.): N/A North: N/A West: N/A

Elevation and Depth (Ft.)	Samples	Soil symbols	Soil Description	USCS symbol	Moisture content,%	Minus #200 sieve, %	Liquid limit	Plastic limit	Plasticity index	SPT N-Value: Blows per foot (N)	SPT N-Value CURVE (10 30 50)
0			SAND, fine grained, silty, brown, loose, moist	SM	14	26	NV	NV	NP	6	
			-medium dense at 2.5 feet		14	27	NV	NV	NP	11	
5			SAND, fine grained, poorly-graded, silty, brown, medium dense, dry to moist	SP-SM	7	9				12	
			-loose and very moist at 7.5 feet		24	10				9	
10			▽ -very loose and saturated at 10 feet		26	6				3	
15					24	11	NV	NV	NP	2	
20			SAND, fine grained, poorly-graded, brown and multi-color, loose, saturated	SP	22	3				6	
			Termination depth at 21.5 feet								
25											
30											

Groundwater Table Data

Depth	Date	Time
10 FT	06/29/21	4:00 PM

Sample Type
- Auger cutting
- 2" O.D. split spoon
- 3" O.D. split tube
- Thin-walled Shelby tube

Rig type: CME-75
Boring type: HSA
Drilled by: EAH
Logger: AG
Sheet No.: **A-2**

LOG OF TEST BORING No. B-2

Project name: Bird Avenue 18-Inch Gravity Sewer Replacement
File No.: LOI21-137
Date drilled: 06/30/21
Boring Location: See Sheet A-1.2
Elevation (ft.): N/A North: N/A West: N/A

Elevation and Depth (Ft.)	Samples	Soil symbols	Soil Description	USCS symbol	Moisture content, %	Minus #200 sieve, %	Liquid limit	Plastic limit	Plasticity index	SPT N-Value: Blows per foot (N)	SPT N-Value CURVE (10 30 50)
0			4" ASPHALT PAVEMENT								
			6" BASE COURSE								
			SAND, fine grained, silty, brown, medium dense, moist, with gravel		15	15	NV	NV	NP	23	
					15	17	NV	NV	NP	11	
5			-very loose and dry to moist at 5 feet	SM	7	16				2	
			-loose and very moist at 7.5 feet		27	26				9	
10			SAND, fine grained, poorly-graded, silty, brown and multi-color, very loose, saturated		21	7				2	
15			-medium dense at 15 feet	SP-SM	27	7	NV	NV	NP	10	
20			SAND, fine grained, silty, dark gray, very loose, saturated	SM	26	14				2	
			Termination depth at 21.5 feet								
25											
30											

Groundwater Table Data

Depth	Date	Time
10 FT	06/30/21	12:30 PM

Sample Type
- Auger cutting
- 2" O.D. split spoon
- 3" O.D. split tube
- Thin-walled Shelby tube

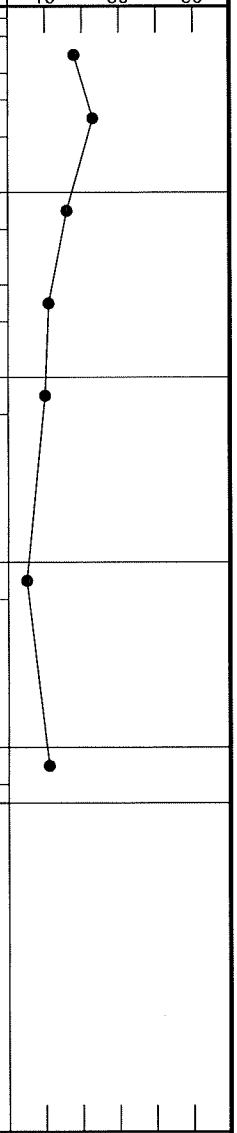
Rig type: CME-75
Boring type: HSA
Drilled by: EAH
Logger: AG
Sheet No.: **A-3**

LOG OF TEST BORING No. B-3

Project name: Bird Avenue 18-Inch Gravity Sewer Replacement
File No.: LOI21-137
Date drilled: 06/29/21
Boring Location: See Sheet A-1.2
Elevation (ft.): N/A North: N/A West: N/A

Elevation and Depth (Ft.)	Samples	Soil symbols	Soil Description	USCS symbol	Moisture content, %	Minus #200 sieve, %	Liquid limit	Plastic limit	Plasticity index	Blows per foot (N)
0			3.5" ASPHALT PAVEMENT							
			6" BASE COURSE							
			SAND, fine grained, silty, brown, medium dense, dry to moist, with gravel		5	17	NV	NV	NP	18
					5	23				23
5			-moist at 5 feet		14	21				16
			-saturated at 7.5 feet	SM	23	13				11
10					26	16	NV	NV	NP	10
15			SAND, fine grained, poorly-graded, brown and multi-color, loose, saturated	SP	23	2				5
20					22	2				11
			Termination depth at 21.5 feet							
25										
30										

SPT N-Value CURVE



Groundwater Table Data

Depth	Date	Time
7.5 FT	06/29/21	12:10 PM

Sample Type
- Auger cutting
- 2" O.D. split spoon
- 3" O.D. split tube
- Thin-walled Shelby tube

Rig type: CME-75
Boring type: HSA
Drilled by: EAH
Logger: AG
Sheet No.: **A-4**

LOG OF TEST BORING No. B-4

Project name: Bird Avenue 18-Inch Gravity Sewer Replacement
File No.: LOI21-137
Date drilled: 06/29/21
Boring Location: See Sheet A-1.2
Elevation (ft.): N/A North: N/A West: N/A

Elevation and Depth (Ft.)	Samples	Soil symbols	Soil Description	USCS symbol	Moisture content, %	Minus #200 sieve, %	Liquid limit	Plastic limit	Plasticity index	SPT N-Value: Blows per foot (N)	SPT N-Value CURVE (10 30 50)
0			2.5" ASPHALT PAVEMENT								
			6" BASE COURSE								
			SILT, sandy, brown, stiff, moist	ML	13	52	NV	NV	NP	15	
			SAND, fine grained, silty, brown, medium dense, moist		15	29	NV	NV	NP	11	
5			-loose at 5 feet	SM	21	23				7	
			▽ -very loose and saturated at 7.5 feet		32	24	NV	NV	NP	3	
10			SAND, fine grained, poorly-graded, silty, brown and multi-color, very loose, saturated		35	11				2	
15			-loose at 15 feet	SP-SM	21	5				7	
20			SAND, fine grained, poorly-graded, brown and multi-color, very loose, saturated	SP	25	2				2	
			Termination depth at 21.5 feet								
25											
30											

Groundwater Table Data

Depth	Date	Time
7.5 FT	06/29/21	10:41 AM

Sample Type
- Auger cutting
- 2" O.D. split spoon
- 3" O.D. split tube
- Thin-walled Shelby tube

Rig type: CME-75
Boring type: HSA
Drilled by: EAH
Logger: AG
Sheet No.: **A-5**

LOG OF TEST BORING No. B-5

Project name: Bird Avenue 18-Inch Gravity Sewer Replacement
File No.: LOI21-137
Date drilled: 06/30/21
Boring Location: See Sheet A-1.2
Elevation (ft.): N/A North: N/A West: N/A

Elevation and Depth (Ft.)	Samples	Soil symbols	Soil Description	USCS symbol	Moisture content,%	Minus #200 sieve, %	Liquid limit	Plastic limit	Plasticity index	SPT N-Value: Blows per foot (N)	SPT N-Value CURVE (10 30 50)
0			3.5" ASPHALT PAVEMENT								
			6" BASE COURSE								
			SAND, fine grained, clayey, brown, medium dense, moist, with gravel	SC	13	42	28	15	13	12	
			SAND, fine grained, silty, brown, loose, moist	SM	14	48	NV	NV	NP	7	
5			SAND, fine grained, poorly-graded, silty, brown and multi-color, loose, dry to moist	SP-SM	8	6				7	
			▽ -very loose and saturated at 7.5 feet		26	6				2	
10					31	10	NV	NV	NP	2	
15			SAND, fine grained, clayey, silty, brown, very loose, saturated	SC-SM	30	18	21	16	5	2	
20			GRAVEL, well-graded, sandy, brown, medium dense, dry to moist	GW	8	4				27	
			Termination depth at 21.5 feet								
25											
30											

Groundwater Table Data

Depth	Date	Time
7.5 FT	06/30/21	9:40 AM

Sample Type
- Auger cutting
- 2" O.D. split spoon
- 3" O.D. split tube
- Thin-walled Shelby tube

Rig type: CME-75
Boring type: HSA
Drilled by: EAH
Logger: AG
Sheet No.: **A-6**

ENGINEERS

SUMMARY OF RESULTS

Project: Bird Avenue 18-Inch Gravity Sewer Replacement
El Paso, El Paso County, Texas

LOI Project No.: LOI21-137

Date: 07/08/21

Boring No.	Depth (ft.)	% Moisture Content	% Material passing # 4	% Material passing # 40	% Material minus # 200	LL	PL	PI	Soil Classification
1	0-1½	14	91	83	26	NV	NV	NP	Silty sand (SM)
1	2½-4	14	100	99	27	NV	NV	NP	Silty sand (SM)
1	5½-6	7			9				Poorly-graded sand (SP-SM) with silt
1	7½-9	24			10				Poorly-graded sand (SP-SM) with silt
1	10-11½	26	100	95	6				Poorly-graded sand (SP-SM) with silt
1	15-16½	24			11	NV	NV	NP	Poorly-graded sand (SP-SM) with silt
1	20-21½	22	99	79	3				Poorly-graded sand (SP)
2	0-1½	15	61	46	15	NV	NV	NP	Silty sand (SM) with gravel
2	2½-4	15			17	NV	NV	NP	Silty sand (SM)
2	5½-6	7			16				Silty sand (SM)
2	7½-9	27	100	99	26				Silty sand (SM)
2	10-11½	21	100	99	7				Poorly-graded sand (SP-SM) with silt
2	15-16½	27			7	NV	NV	NP	Poorly-graded sand (SP-SM) with silt
2	20-21½	26	99	88	14				Silty sand (SM)
3	0-1½	5	62	39	17	NV	NV	NP	Silty sand (SM) with gravel
3	2½-4	5	100	98	23				Silty sand (SM)
3	5½-6	14			21				Silty sand (SM)
3	7½-9	23			13				Silty sand (SM)

ENGINEERS

SUMMARY OF RESULTS

Project: Bird Avenue 18-Inch Gravity Sewer Replacement
El Paso, El Paso County, Texas

LOI Project No.: LOI21-137

Date: 07/08/21

Boring No.	Depth (ft.)	% Moisture Content	% Material passing # 4	% Material passing # 40	% Material minus # 200	LL	PL	PI	Soil Classification
3	10-11½	26	99	91	16	NV	NV	NP	Silty sand (SM)
3	15-16½	23	99	79	2				Poorly-graded sand (SP)
3	20-21½	22			2				Poorly-graded sand (SP)
4	0-1½	13	79	66	52	NV	NV	NP	Sandy silt (ML)
4	2½-4	15			29	NV	NV	NP	Silty sand (SM)
4	5½-6	21	100	100	23				Silty sand (SM)
4	7½-9	32			24	NV	NV	NP	Silty sand (SM)
4	10-11½	35			11				Poorly-graded sand (SP-SM) with silt
4	15-16½	21	94	81	5				Poorly-graded sand (SP-SM) with silt
4	20-21½	25			2				Poorly-graded sand (SP)
5	0-1½	13	84	73	42	28	15	13	Clayey sand (SC) with gravel
5	2½-4 UPPER	14			48	NV	NV	NP	Silty sand (SM)
5	5½-6	8	95	80	6				Poorly-graded sand (SP-SM) with silt
5	7½-9	26			6				Poorly-graded sand (SP-SM) with silt
5	10-11½	31			10	NV	NV	NP	Poorly-graded sand (SP-SM) with silt
5	15-16½	30			18	21	16	5	Clayey, silty sand (SC-SM)
5	20-21½	8	44	18	4				Well-graded gravel (GW) with sand

REPORT OF MOISTURE-DENSITY RELATIONSHIP, SIEVE ANALYSIS, AND PLASTICITY INDEX

ASTM D-2487, C-136, D-4318, D-1557

ENGINEERS

Project Name: Bird Avenue 18-Inch Gravity Sewer Replacement
El Paso, El Paso County, Texas

Project Number: LOI21-137

Client: Huitt- Zollars
5822 Cromo Drive, Suite 210
El Paso, Texas 79912

Sample date: 6/29/21

Sample Location: Existing material; Sample collected at soil boring B-1; 0'-5' in depth.

Sampler: EH

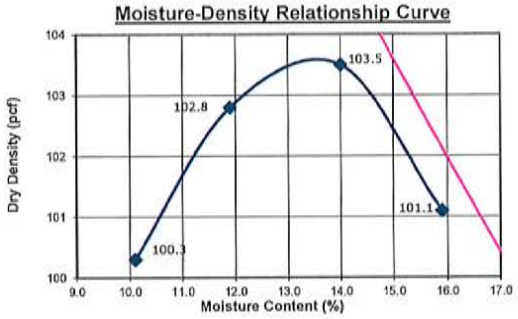
Soil Classification: Silty sand (SM)

Sample Number: 062921-B1

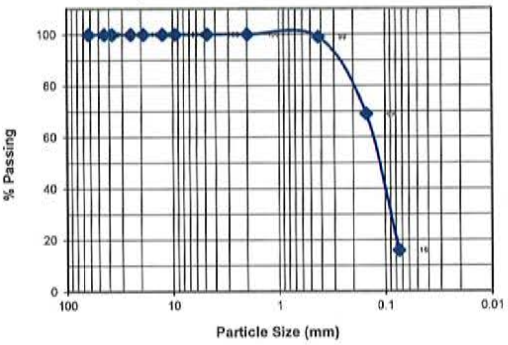
Method Used: B
Preparation: Dry
Rammer: Mechanical
Specific Gravity: 2.63 (estimated)
As Received Water Content: 2 %

Modified Maximum Dry Unit Weight: 103.6 pcf
Modified Optimum Water Content: 13.5 %

Moisture-Density Relationship Curve



Grain-Size Distribution



Sieve Analysis

Sieve Opening Size		Retained (%)		Passing (%)	
Std.	mm	Actual	Specs.	Actual	Specs.
2-1/2"	62.50	0	-	100	-
1-3/4"	44.50	0	-	100	-
1-1/2"	37.50	0	-	100	-
1"	25.00	0	-	100	-
3/4"	19.00	0	-	100	-
1/2"	12.50	0	-	100	-
3/8"	9.50	0	-	100	-
#4	4.75	0	-	100	-
#10	2.00	0	-	100	-
#40	0.425	1	-	99	-
#100	0.150	31	-	69	-
#200	0.075	84	-	16	-

Gradation Parameters

D_{10}=	0.05	C_c=	1.40
D_{30}=	0.09	C_u=	2.93
D_{60}=	0.14	-	-

Plasticity Index

Process: Air-dry

Actual	**LL=**	NV	**PL=**	NV	**PI=**	NP
Typical	**LL=**	-	**PL=**	-	**PI=**	-

Sheet No. A-9

REPORT OF MOISTURE-DENSITY RELATIONSHIP, SIEVE ANALYSIS, AND PLASTICITY INDEX

ASTM D-2487, C-136, D-4318, D-1557

ENGINEERS

Project Name: Bird Avenue 18-Inch Gravity Sewer Replacement
El Paso, El Paso County, Texas

Project Number: LOI21-137

Client: Huitt- Zollars
5822 Cromo Drive, Suite 210
El Paso, Texas 79912

Sample date: 6/29/21

Sample Location: Existing material; Sample collected at soil boring B-2; 0' to 5' in depth.

Sampled by: EH

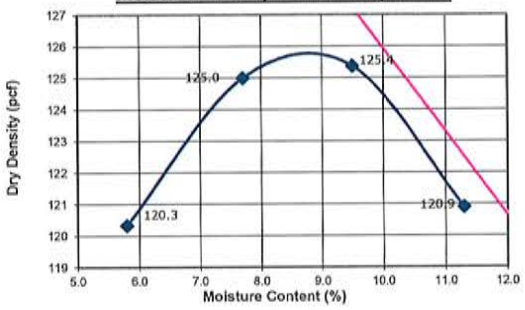
Soil Classification: Silty sand with gravel (SM)

Sample Number: 062921-B2

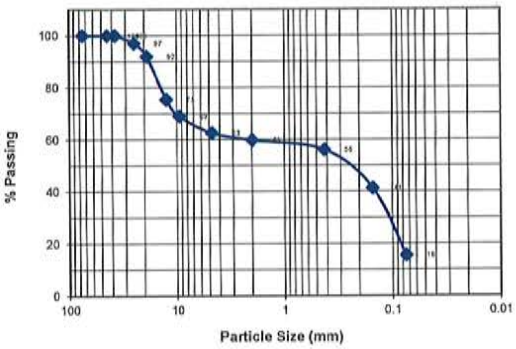
Method Used: C
Preparation: Dry
Rammer: Mechanical
Specific Gravity: 2.63 (estimated)
As Received Water Content: 2 %

Corrected Maximum Dry Unit Weight: 125.8 pcf
Corrected Optimum Water Content: 8.8 %

Moisture-Density Relationship Curve



Grain-Size Distribution



Sieve Analysis

Sieve Opening Size		Retained (%)		Passing (%)	
Std.	mm	Actual	Specs.	Actual	Typical
3"	75.00	0	-	100	-
1-3/4"	44.50	0	-	100	-
1-1/2"	37.50	0	-	100	-
1"	25.00	3	-	97	-
3/4"	19.00	8	-	92	-
1/2"	12.50	25	-	75	-
3/8"	9.50	31	-	69	-
#4	4.75	37	-	63	-
#10	2.00	40	-	60	-
#40	0.425	44	-	56	-
#100	0.150	59	-	41	-
#200	0.075	84	-	16	-

Gradation Parameters

D_{10}=	0.05	C_c=	0.13
D_{30}=	0.12	C_u=	45.86
D_{60}=	2.20	-	-

Plasticity Index

Process: Air-dry

Actual:	**LL=**	NV	**PL=**	NV	**PI=**	NP
Typical:	**LL=**	-	**PL=**	-	**PI=**	-

Sheet No. A-10

REPORT OF MOISTURE-DENSITY RELATIONSHIP, SIEVE ANALYSIS, AND PLASTICITY INDEX

ASTM D-2487, C-136, D-4318, D-1557

Project Name: Bird Avenue 18-Inch Gravity Sewer Replacement
El Paso, El Paso County, Texas

Project Number: LOI21-137

Client: Huitt- Zollars
5822 Cromo Drive, Suite 210
El Paso, Texas 79912

Sample date: 6/29/21

Sample Location: Existing material; Sample collected at soil boring B-3; 0' to 5' in depth.

Sampled by: EH

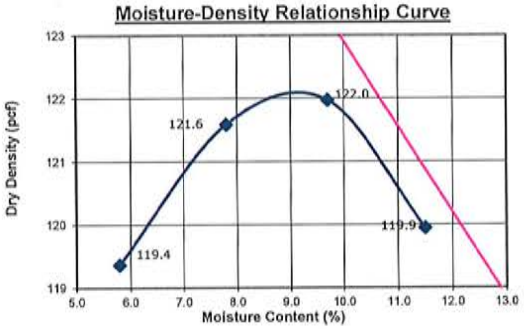
Soil Classification: Silty sand with gravel (SM)

Sample Number: 062921-B3

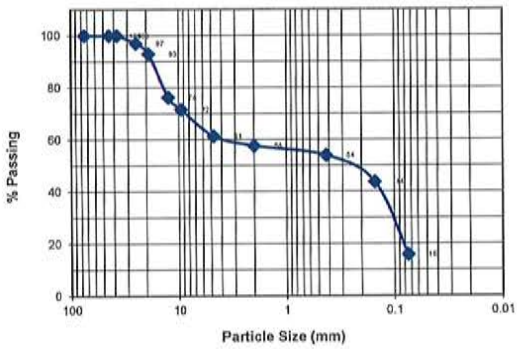
Method Used: C
Preparation: Dry
Rammer: Mechanical
Specific Gravity: 2.63 (estimated)
As Received Water Content: 2 %

Corrected Maximum Dry Unit Weight: 122.1 pcf
Corrected Optimum Water Content: 9.1 %

Moisture-Density Relationship Curve



Grain-Size Distribution



Sieve Analysis

Sieve Opening Size		Retained (%)		Passing (%)	
Std.	mm	Actual	Specs.	Actual	Typical
3"	75.00	0	-	100	-
1-3/4"	44.50	0	-	100	-
1-1/2"	37.50	0	-	100	-
1"	25.00	3	-	97	-
3/4"	19.00	7	-	93	-
1/2"	12.50	24	-	76	-
3/8"	9.50	28	-	72	-
#4	4.75	39	-	61	-
#10	2.00	42	-	58	-
#40	0.425	46	-	54	-
#100	0.150	56	-	44	-
#200	0.075	84	-	16	-

Gradation Parameters

D_{10}=	0.05	C_c=	0.07
D_{30}=	0.11	C_u=	78.63
D_{60}=	3.73	-	-

Plasticity Index

Process: Air-dry

Actual:	**LL=**	NV	**PL=**	NV	**PI=**	NP
Typical:	**LL=**	-	**PL=**	-	**PI=**	-

Sheet No. A-11

REPORT OF MOISTURE-DENSITY RELATIONSHIP, SIEVE ANALYSIS, AND PLASTICITY INDEX

ASTM D-2487, C-136, D-4318, D-1557

ENGINEERS

Project Name: Bird Avenue 18-Inch Gravity Sewer Replacement
El Paso, El Paso County, Texas

Project Number: LOI21-137

Client: Huitt- Zollars
5822 Cromo Drive, Suite 210
El Paso, Texas 79912

Sample date: 6/30/21

Sample Location: Existing material; Sample collected at soil boring B-5; 0'-5' in depth.

Sampler: EH

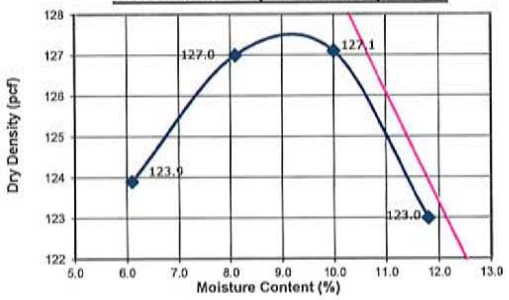
Soil Classification: Silty sand (SM)

Sample Number: 063021-B5

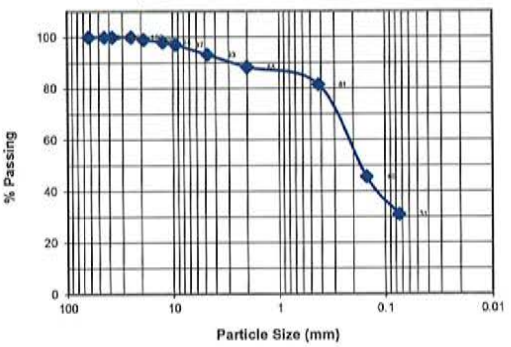
Method Used: B
Preparation: Wet
Rammer: Mechanical
Specific Gravity: 2.63 (estimated)
As Received Water Content: 2 %

Corrected Maximum Dry Unit Weight: 127.5 pcf
Corrected Optimum Water Content: 9.2 %

Moisture-Density Relationship Curve



Grain-Size Distribution



Sieve Analysis

Sieve Opening Size		Retained (%)		Passing (%)	
Std.	mm	Actual	Specs.	Actual	Specs.
2-1/2"	62.50	0	-	100	-
1-3/4"	44.50	0	-	100	-
1-1/2"	37.50	0	-	100	-
1"	25.00	0	-	100	-
3/4"	19.00	1	-	99	-
1/2"	12.50	2	-	98	-
3/8"	9.50	3	-	97	-
#4	4.75	7	-	93	-
#10	2.00	12	-	88	-
#40	0.425	19	-	81	-
#100	0.150	54	-	46	-
#200	0.075	69	-	31	-

Gradation Parameters

D_{10}=	0.02	C_c=	0.84
D_{30}=	0.07	C_u=	10.78
D_{60}=	0.26	-	-

Plasticity Index

Process: Air-dry

Actual	**LL=**	NV	**PL=**	NV	**PI=**	NP
Typical	**LL=**	-	**PL=**	-	**PI=**	-

Sheet No. A-12

REPORT OF CALIFORNIA BEARING RATIO (CBR) TEST

ASTM D-1883

Project Name: Bird Avenue 18-Inch Gravity Sewer Replacement
El Paso, El Paso County, Texas

Project Number: LOI21-137

Client: Huitt- Zollars
5822 Cromo Drive, Suite 210
El Paso, Texas 79912

Sample date: 6/30/21

Sample Location: Existing material; Sample collected at soil boring B-5; 0' to 5' in depth.

Sampler by: EH

USCS Classification: Silty sand (SM)

Sample Number: 063021-B5

MOISTURE-DENSITY DATA:

Compaction Method:	ASTM D-1557 *(Modified Proctor Test)*		
Maximum dry unit weight:	121.5 pcf	**Optimum moisture content:**	11.4 %
		Prescribed relative compaction:	95.0 %

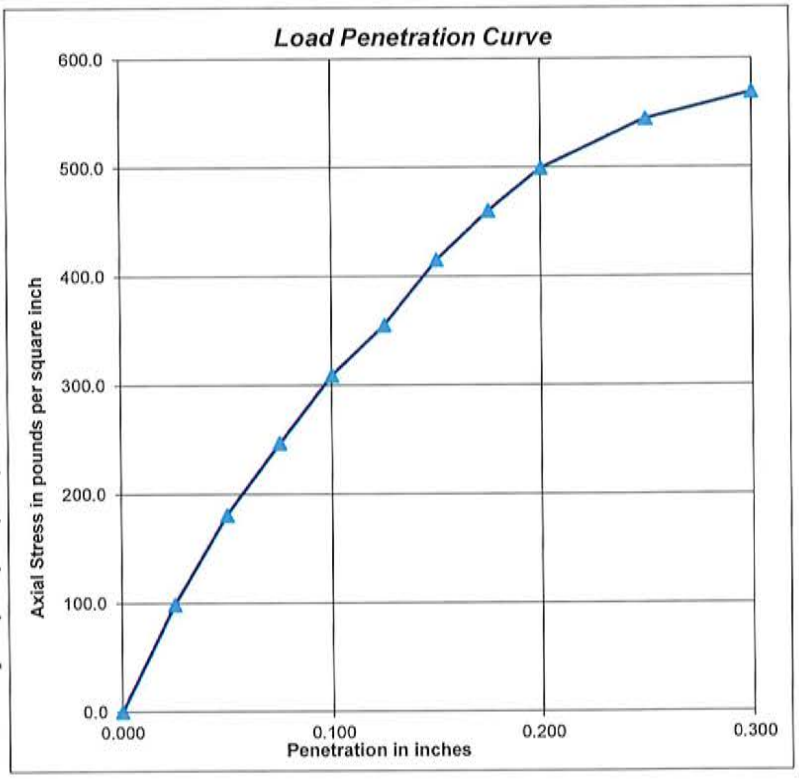
SOAKING PERIOD OUTPUT PARAMETERS:

Initial dry unit weight:	121.7 pcf	**Initial moisture content:**	11.4 %
Final dry unit weight:	120.8 pcf	**Final water content, top 1-inch layer:**	11.2 %
Swell index:	4.0%	**Final water content, middle layer:**	8.2 %

BEARING TEST DATA:

Penetration *(inch.)*	Load *(lbs.)*	Axial Stress *(psi)*
0.000	0	0.0
0.025	300	98.7
0.050	550	180.9
0.075	750	246.7
0.100	940	309.2
0.125	1080	355.3
0.150	1262	415.1
0.175	1399	460.2
0.200	**1518**	**499.3**
0.250	1656	544.7
0.300	1730	569.1

Corrected 0.1 inch penetration:	31%
Corrected 0.2 inch penetration:	**33%**



Sheet No. A-13

ENGINEERS

APPENDIX B

SOIL TERMINOLOGY

ENGINEERS

COARSE GRAINED SOILS: More than 50 percent retained on No. 200 sieve. Includes fine, medium, or coarse grained (depending on grain size) gravel and sand, and silty and/or clayey gravel and sand. Density is described according to relative density measured in the laboratory, or sampler resistance in the field as follows:

Penetration Resistance* (Blows per Foot)	Descriptive Term	Relative Density** (Percent)
0 – 4	Very Loose	0 - 15
5 - 9	Loose	15 – 35
10 - 29	Medium Dense	35 – 65
30 - 49	Dense	65 - 85
More than 50	Very Dense	85 - 100

* From Standard Penetration Test with 140-pound hammer, 30 inch drop.

** From relative density tests on undisturbed sand sample.

FINE GRAINED SOILS: More than 50 percent passing through the No. 200 sieve. Includes organic and inorganic silt and clay, gravelly and/or sandy silt and clay, silty clay, and clayey silt. Consistency is described according to shear strength, from unconfined compression tests in the laboratory, penetrometer tests in the field or laboratory, or sampler resistance in the field as follows:

Compressive Strength* (Tons per Square Foot)	Descriptive Term	Penetration Resistance** (Blows per Foot)
Less than 0.25	Very Soft	Less than 2
0.25 - 0.50	Soft	2 - 4
0.50 - 1.00	Firm	5 - 8
1.00 - 2.00	Stiff	9 - 15
2.00 - 4.00	Very Stiff	16 - 50
4.00 and higher	Hard	50 and higher

* From unconfined compression strength test.

** From Standard Penetration Test with 140-pound hammer, 30 inch drop.

Slickensided: With inclined planes of weakness of slick and glassy appearance.
Fissured: With shrinkage cracks that are frequently filled with fine sand.
Laminated: With thin layers of varying colors and texture.
Interbedded: With alternate layers of different soil types.
Calcareous: With noticeable quantities of calcium carbonate.
Sensitive: Applies to cohesive soils that are subject to loss of strength when remolded.
Well graded: With wide range in grain sizes and good distribution of intermediate particle sizes.
Poorly graded: With one predominant grain size, or a poor distribution with intermediate sizes missing.

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SOIL SYMBOLS

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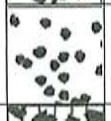
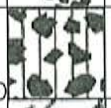
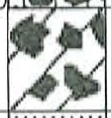
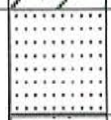
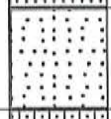
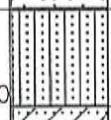
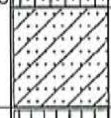
Identification of the major soil divisions used to distinguish the change of a different stratum. For their combinations and a more detailed description, see UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487-00)

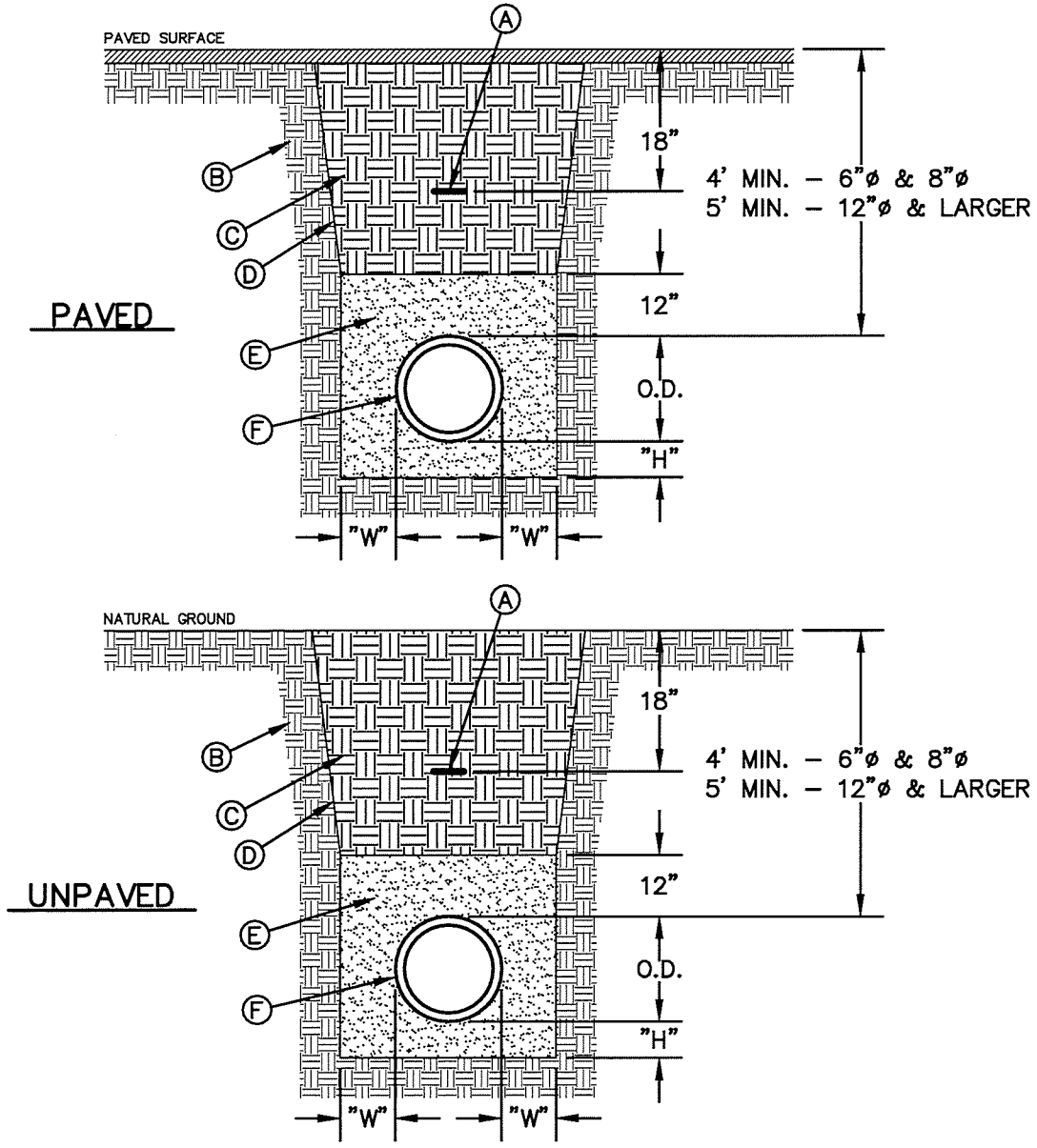
MAJOR SOIL DIVISIONS			SOIL SYMBOL	USCS SYMBOL	TYPICAL NAME
Coarse-Grained Soils (< 50% pass No. 200 sieve)	GRAVELS (<50% pass No. 4 sieve)	Clean Gravels (< 5% pass No. 200 sieve)		GW	Well-Graded Gravels
				GP	Poorly-Graded Gravels
		Gravels with fines (> 12% pass No. 200 sieve)		GM	Silty Gravels
				GC	Clayey Gravels
	SANDS (> 50% pass No. 4 sieve)	Clean Sands (< 5% pass No. 200 sieve)		SW	Well-Graded Sands
				SP	Poorly-Graded Sands
		Sands with fines (> 12% pass No. 200 sieve)		SM	Silty Sands
				SC	Clayey Sands
Fine-Grained Soils (> 50% pass No. 200 sieve)	SILTS	Silts of Low Plasticity (*LL < 50)		ML	Inorganic Silts (slightly plastic)
		Silts of High Plasticity (*LL > 50)		MH	Inorganic Silts (elastic)
	CLAYS	Clays of Low Plasticity (*LL < 50)		CL	Inorganic Clays (lean clays)
		Clays of High Plasticity (*LL > 50)		CH	Inorganic Clays (Fat clays)

*Liquid Limit of the soil
NV: No value obtained; NP: Non-plastic

Sheet No. B-2

ENGINEERS

APPENDIX C



GENERAL NOTES:

1. BEDDING FOR PRESSURE AND GRAVITY PIPE IN DRY CONDITIONS.
2. PROVIDE TRENCH SAFETY SYSTEM FOR TRENCH DEPTHS GREATER THAN 5 FEET.
3. IF THE NATIVE MATERIAL EXCAVATED FROM THE TRENCH IS UNSUITABLE AS BACKFILL MATERIAL, OR THE REQUIRED COMPACTION IS UNATTAINABLE, THE CONTRACTOR SHALL, AT HIS EXPENSE, IMPORT SELECT MATERIAL TO BE MIXED WITH OR USED IN PLACE OF THE NATIVE MATERIAL. SELECT MATERIAL MUST BE APPROVED BY EPWU. SUBSTITUTE SOIL CEMENT SLURRY (1–SACK) IF REQUIRED IN SPECS.

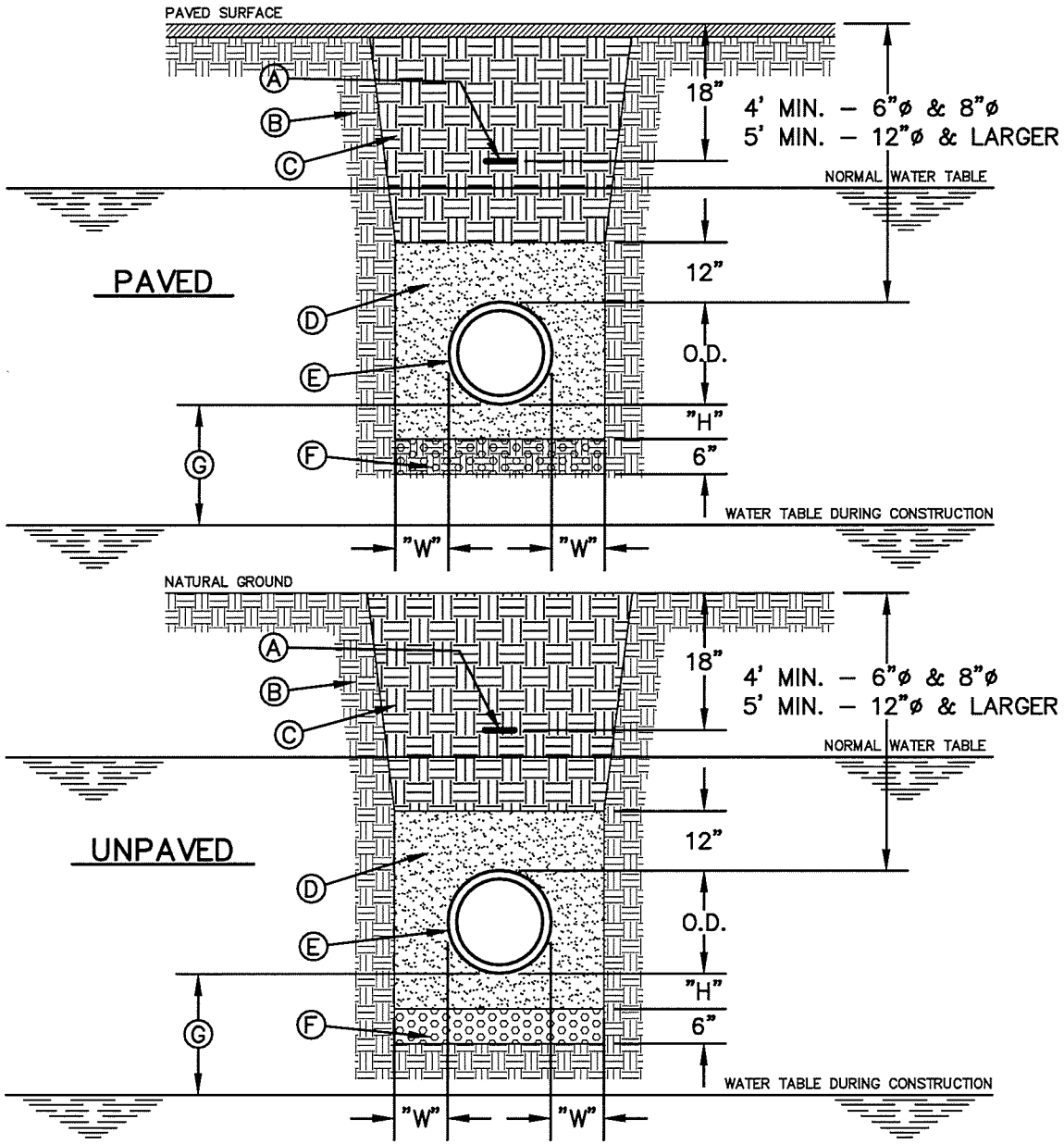
CONSTRUCTION KEY NOTES:

A. APPROVED MARKING TAPE.
B. UNDISTURBED STABLE MATERIAL.
C. NATIVE MATERIAL BACKFILL.
   PAVED CONDITION: COMPACT TO 90% DENSITY PER ASTM D–1557 MODIFIED PROCTOR.
   UNPAVED CONDITION: COMPACT TO 85% DENSITY PER ASTM D–1557 MODIFIED PROCTOR.
   (*SEE NOTE #3 IF THESE PREVIOUS CONDITIONS CANNOT BE MET.)
D. SLOPE TRENCH IN SANDY SOIL CONDITIONS.
E. USE CLASS II OR CLASS III SAND PER ASTM D–2487. NATIVE MATERIAL OR IMPORTED SELECT MATERIAL MEETING OR EXCEEDING THIS REQUIREMENT MAY BE USED. COMPACT TO 85% DENSITY PER ASTM D–1557 MODIFIED PROCTOR (OR 90% D–698 STANDARD PROCTOR).
F. APPROVED PIPE.
G. TRENCH DIMENSIONS AS FOLLOWS:

PIPE DIAMETER	"H"
6" – 30"	4"
GREATER THAN 30"	6"

PIPE DIAMETER	"W"
6" – 30"	8"
GREATER THAN 30"	12"

STANDARD DETAIL	DATE: 4/24/2007 REV: 2/21/2011	EMBEDMENT CLASS "A" FOR PRESSURE PIPE AND GRAVITY PIPE DRY CONDITIONS	N.T.S.	el paso WATER	DETAIL No. 171



GENERAL NOTES:

1. BEDDING FOR PRESSURE PIPE IN WET CONDITIONS.
2. PROVIDE TRENCH SAFETY SYSTEM FOR TRENCH DEPTHS GREATER THAN 5 FEET.
3. A DRY TRENCH MUST BE MAINTAINED WHILE PLACING BEDDING.
4. IF THE NATIVE MATERIAL EXCAVATED FROM THE TRENCH IS UNSUITABLE AS BACKFILL MATERIAL, OR THE REQUIRED COMPACTION IS UNATTAINABLE, THE CONTRACTOR SHALL, AT HIS EXPENSE, IMPORT SELECT MATERIAL TO BE MIXED WITH OR USED IN PLACE OF THE NATIVE MATERIAL. SELECT MATERIAL MUST BE APPROVED BY EPWU. SUBSTITUTE SOIL CEMENT SLURRY (1–SACK) IF REQUIRED IN SPECS.

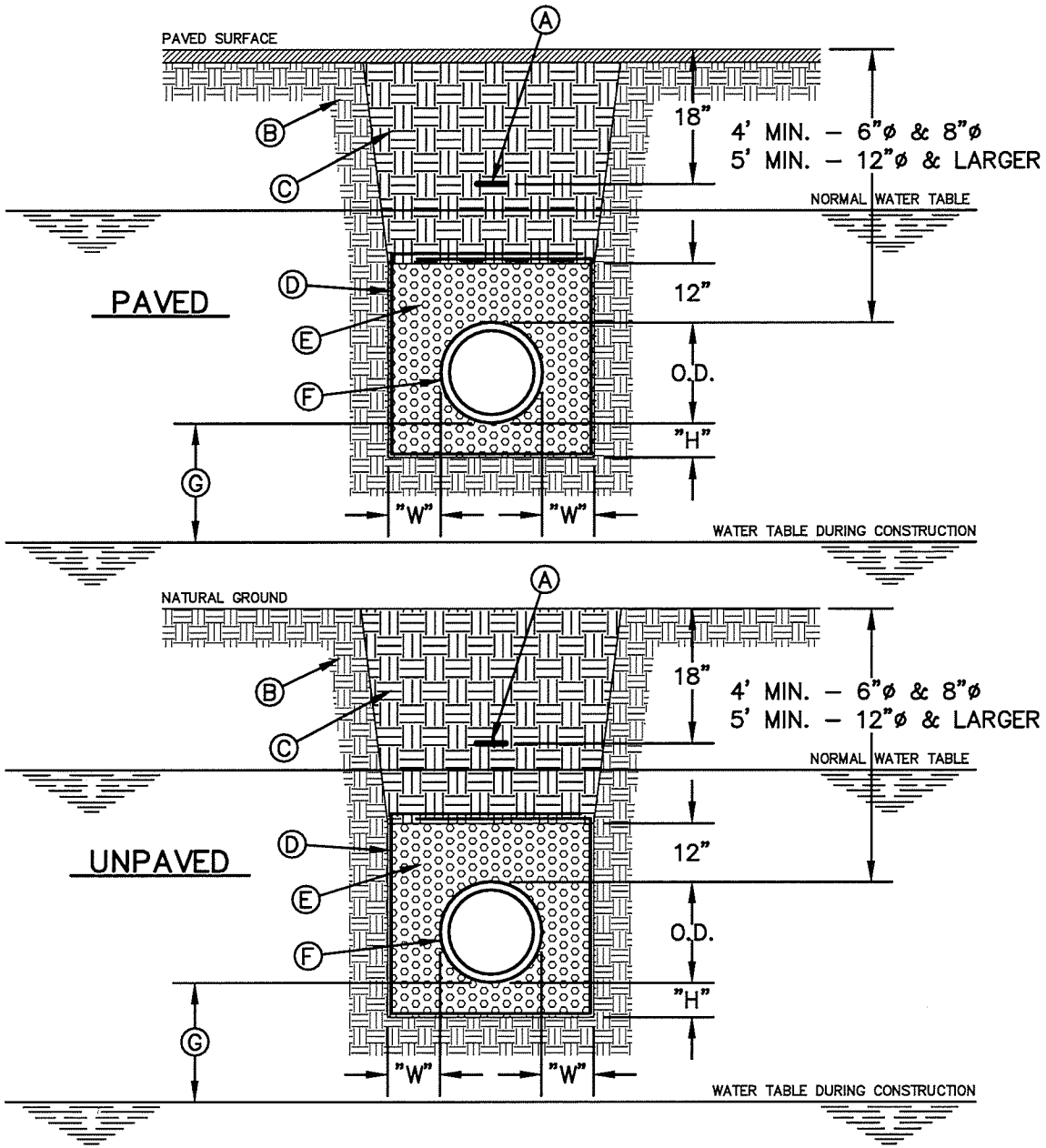
CONSTRUCTION KEY NOTES:

A. APPROVED MARKING TAPE.
B. UNDISTURBED STABLE MATERIAL.
C. NATIVE MATERIAL BACKFILL.
PAVED CONDITION: COMPACT TO 90% DENSITY PER ASTM D–1557 MODIFIED PROCTOR.
UNPAVED CONDITION: COMPACT TO 85% DENSITY PER ASTM D–1557 MODIFIED PROCTOR.
(*SEE NOTE #4 IF THESE PREVIOUS CONDITIONS CANNOT BE MET.)
D. USE CLASS II OR CLASS III SAND PER ASTM D–2487. NATIVE MATERIAL OR IMPORTED SELECT MATERIAL MEETING OR EXCEEDING THIS REQUIREMENT MAY BE USED. COMPACT TO 85% DENSITY PER ASTM D–1557 MODIFIED PROCTOR (OR 90% D–698 STANDARD PROCTOR).
E. APPROVED PIPE (WRAP DUCTILE IRON OR STEEL PIPE IN APPROVED POLYETHYLENE SHEETING, MINIMUM 6 MIL THICKNESS).
F. USE CLASS I GRAVEL PER ASTM D–2321 AND D–2487. NO COMPACTION REQUIRED. USE MINIMAL TAMPING, RODDING OR HAUNCH SLICING CAREFULLY IN THE EMEBEDMENT ZONE. IF REQUIRED BY THE ENGINEER, TEST PER ASTM D–4254 PERCENT OF RELATIVE DENSITY.
G. 18" MINIMUM UNLESS OTHERWISE SPECIFIED.
H. TRENCH DIMENSIONS AS FOLLOWS:

PIPE DIAMETER	"H"
6" – 30"	4"
GREATER THAN 30"	6"

PIPE DIAMETER	"W"
6" – 30"	8"
GREATER THAN 30"	12"

STANDARD DETAIL	DATE: 5/7/2007 REV: 7/6/2020	EMBEDMENT CLASS "B" FOR PRESSURE PIPE WET CONDITIONS	N.T.S.	el paso WATER	DETAIL No. 172



GENERAL NOTES:

1. BEDDING FOR GRAVITY PIPE IN WET CONDITIONS.
2. PROVIDE TRENCH SAFETY SYSTEM FOR TRENCH DEPTHS GREATER THAN 5 FEET.
3. A DRY TRENCH MUST BE MAINTAINED WHILE PLACING BEDDING AND GEOTECHNICAL FABRIC.
4. IF THE NATIVE MATERIAL EXCAVATED FROM THE TRENCH IS UNSUITABLE AS BACKFILL MATERIAL, OR THE REQUIRED COMPACTION IS UNATTAINABLE, THE CONTRACTOR SHALL, AT HIS EXPENSE, IMPORT SELECT MATERIAL TO BE MIXED WITH OR USED IN PLACE OF THE NATIVE MATERIAL. SELECT MATERIAL MUST BE APPROVED BY EPWU. SUBSTITUTE SOIL CEMENT SLURRY (1–SACK) IF REQUIRED IN SPECS.

CONSTRUCTION KEY NOTES:

A. APPROVED MARKING TAPE.
B. UNDISTURBED STABLE MATERIAL.
C. NATIVE MATERIAL BACKFILL.
   PAVED CONDITION: COMPACT TO 90% DENSITY PER ASTM D–1557 MODIFIED PROCTOR.
   UNPAVED CONDITION: COMPACT TO 85% DENSITY PER ASTM D–1557 MODIFIED PROCTOR. (*SEE NOTE #4 IF THESE PREVIOUS CONDITIONS CANNOT BE MET.)
D. APPROVED GEOTECHNICAL FABRIC WITH A STANDARD OVERLAP THAT IS 2 FEET EXCEPT WHERE TRENCH WIDTH EXCEEDS 3 FEET, THE OVERLAP AT TOP SHALL BE 3 FEET.
E. USE CLASS I GRAVEL PER ASTM D–2321 AND D–2487. NO COMPACTION REQUIRED. USE MINIMAL TAMPING, RODDING OR HAUNCH SLICING CAREFULLY IN THE EMBEDMENT ZONE. IF REQUIRED BY THE ENGINEER, TEST PER ASTM D–4254 PERCENT OF RELATIVE DENSITY.
F. APPROVED PIPE.
G. 18" MINIMUM UNLESS OTHERWISE SPECIFIED.
H. TRENCH DIMENSIONS AS FOLLOWS:

PIPE DIAMETER	"H"
6" – 30"	4"
GREATER THAN 30"	6"

PIPE DIAMETER	"W"
6" – 30"	8"
GREATER THAN 30"	12"

STANDARD DETAIL	DATE: 5/7/2007 REV: 7/6/2020	EMBEDMENT CLASS "C" FOR GRAVITY PIPE WET CONDITIONS	N.T.S.	el paso WATER	DETAIL No. 173