JULY 2022

GEOTECHNICAL ENGINEERING REPORT

PALMER MUNICIPAL AIRPORT

CONSTRUCT TAXIWAY N &
IMPROVE AIRPORT
DRAINAGE

Geotechnical
Engineering Report
Palmer Municipal Airport

2022

Prepared For:
CITY OF PALMER
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Prepared for:

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ABBREVIATIONS

AASHTO..... American Association of State Highway and Transportation Officials

ASTM ..... American Society for Testing and Materials

bgs..... Below the existing ground surface

Client..... City of Palmer

DOT&PF.....Alaska Department of Transportation and Public Facilities

HDL..... HDL Engineering Consultants, LLC

I.D.....Inside diameter

MPT.....Modified Penetration Test

msl.....mean sea level

O.D. ..... Outside diameter

PAQ.....Palmer Municipal Airport

RAP.....Recycled asphalt pavement

Report.....Geotechnical Engineering Report

RSA ..... Runway Safety Area

Site.....Palmer Municipal Airport, Palmer, Alaska

Standard Specifications.....DOT&PF Standard Specifications for Airport Construction

USCS ..... Unified Soil Classification System

INTRODUCTION

In accordance with the request and authorization of the City of Palmer (Client), HDL Engineering Consultants, LLC (HDL) conducted a geotechnical engineering evaluation of the subsurface conditions at the Palmer Municipal Airport (PAQ) in Palmer, Alaska (Site) to support airfield improvements.

This Geotechnical Engineering Report (Report) provides the findings, conclusions, and recommendations that HDL derived from the geotechnical evaluation. This Report is subject to the limitations provided in Appendix A.

Scope of Services

HDL's objective for this project was to evaluate the subsurface conditions near the proposed improvements. To achieve our objective, HDL:

- Advanced thirty-one (31) borings; Excavated four (4) test pits;
- Performed one (1) infiltration test;
- Classified soil samples recovered from the borings and test pits based on visual observations and prepared boring and test pit logs;
- Performed laboratory tests on select samples taken from the borings and test pits;
- Prepared this Report, which summarizes HDL's findings and provides geotechnical recommendations for the proposed improvements.

Summary

This section provides a summary of the geotechnical evaluation for the convenience of the non-technical reader. Read the summary in complete context with the remaining Report.

1. Borings and test pits generally encountered an organic mat and topsoil at the ground surface underlain by a layer of silt followed by sand and gravel extending to the termination depths. Cobbles were present in select borings within the sand and gravel layers. The borings and test pits did not encounter groundwater.
2. Fill placed on the Site should be placed and compacted in accordance with Alaska Department of Transportation and Public Facilities (DOT&PF) Standard Specifications for Airport Construction (Standard Specifications).
3. Fill placed below the structural section should consist of mineral soil that is free of debris, ice, excess moisture, and other deleterious materials, and meet Suitable Material requirements for P-152, Excavation, Subgrade, and Embankment.
4. Non-frost susceptible soils to highly frost susceptible soils (NFS to F4) were encountered in the borings. The risk of frost related issues at the Site will increase if the frost susceptible soils are left in place. The risk of frost related issues can be reduced by removing and replacing the frost susceptible soils.

5. The granular fill encountered at the surface of the proposed construction access road and within the Taxiway B embankment generally meets the Suitable Material requirements for P-152 and may be used at the bottom of the structural section for the Taxiway J extensions, pending confirmation testing during construction.
6. The native silts will be sensitive to moisture and may be difficult to place, compact, and traffic on if exposed to rainfall or runoff during construction.
7. The calculated infiltration rate near the proposed infiltration gallery was 0.14 minutes per inch.

BACKGROUND

The proposed improvements are located at PAQ in Palmer, Alaska. Figure 1 provides a map of the Site location.

Existing Conditions

PAQ currently has a 6,008 foot paved main runway (16/34), a 3,617 foot paved crosswind runway (10/28), a 1,560 foot gravel runway, two paved aircraft aprons, and 10 paved taxiways. Ditching and culverts direct surface runoff to the south east side of the Runway 34 Runway Safety Area (RSA) where water collects and percolates into the soil.

Proposed Development

The proposed improvements include the following:

- Construct Taxiway N;
- Extend and realign Taxiway J;
- Remove Taxiway B west of Taxiway A;
- Construct Apron E;
- Widen shoulders on Taxiway L;
- Build a construction access road;
- Construct an infiltration gallery east of the Runway 34 RSA;
- Grade designated infield areas to promote drainage to existing and new storm water collection systems; and,
- Improve airport lighting.

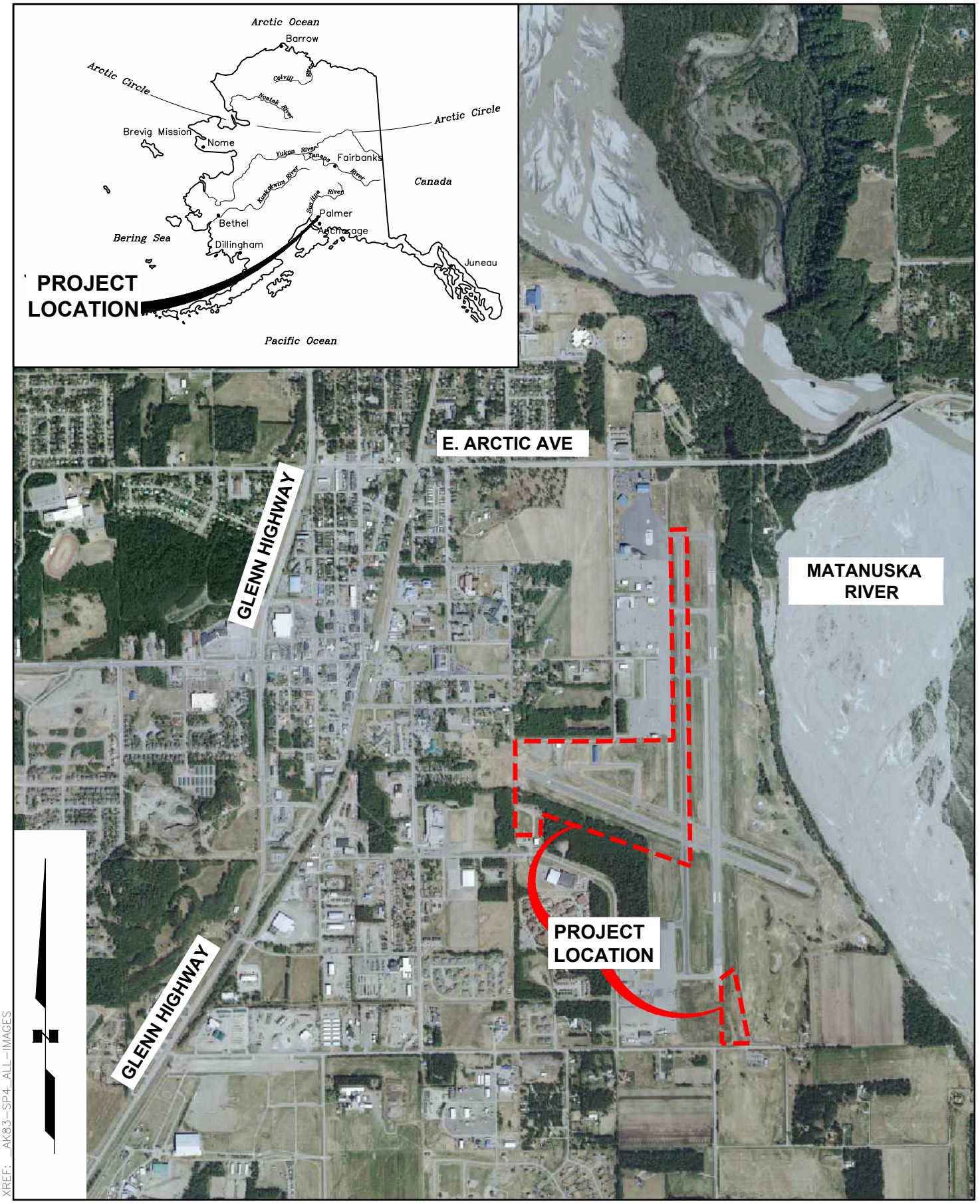

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Figure 1
VICINITY MAP
PALMER MUNICIPAL AIRPORT
CONSTRUCT TAXIWAY N AND IMPROVE AIRPORT DRAINAGE
PALMER, AK

We understand that Taxiway N may be used by the entire fleet mix but Taxiway J will only be used by aircraft weighing less than 60,000 pounds. We understand Apron E will primarily be used by aircraft weighing less than 4,000 pounds but may be used by aircraft weighing up to 25,000 pounds.

PREVIOUS GEOTECHNICAL EVALUATIONS

Geotechnical data available from previously completed evaluations near PAQ was reviewed. Summaries of the data reviewed are provided below and excerpts from the reports are provided in Appendix B.

Palmer Taxiway "A" Improvement Project - Geotechnical Report - Palmer, Alaska, March 2002

Eighteen (18) test holes were drilled between October 4 and 11, 2001 to support design of the proposed Taxiway A. The depth of the test holes ranged from 10.5 feet to 16.5 feet below the existing ground surface (bgs). Test holes were performed along the proposed Taxiway A, Taxiway E, and Taxiway F.

Test holes generally encountered an organic layer at the surface underlain by very loose to loose sandy silt extending to depths between 3.5 and 8.5 feet bgs. Medium dense to very dense gravels with varying amounts of sand, silt, and cobbles were encountered below the sandy silt and extended to the termination depths. Groundwater was not encountered in the test holes.

Palmer Airport Apron "A" and Taxiway "J" and "L" - Geotechnical Report - Palmer, Alaska, January 2004

Thirteen (13) test holes were drilled for the Apron A, Taxiway J and L project between July 16 and 17, 2003. The depth of the test holes ranged from 15 feet to 20 feet bgs. Test holes were performed in or near the proposed Apron A, Taxiway J, and Taxiway L.

Test holes generally encountered a layer of very loose to medium dense silt, with varying amounts of sand and organics underlain by medium dense to dense gravels and sands with varying amounts of silt extending to the termination depths. Groundwater was not encountered in the test holes.

Palmer Airport Rehabilitate Runway 9/27 and Related Improvements - Geotechnical Report - Palmer, Alaska, November 2005

Seventeen (17) test holes were drilled between September 21 and 22, 2005 to support rehabilitation design of Runway 9/27, Taxiway B, and the southwest commercial apron (large aircraft apron). The depth of the test holes ranged from 14 feet to 15 feet bgs. Fourteen (14) test holes were performed along Runway 9/27 and Taxiway B, and three (3) test holes were performed north of the large aircraft apron in the area of the apron expansion proposed for this project.

Test holes performed in the runway and taxiway generally encountered a structural section ranging from 1.7 feet to 2.7 feet thick underlain by a layer of sandy silt.

Medium dense to very dense sandy gravel with varying amounts of silt was encountered beneath the silt layer and extended to the termination depths. Test holes performed in the proposed apron expansion encountered an organic mat underlain by sandy silt followed by sandy gravel with varying amounts of silt extending to the termination depths. Groundwater was not encountered in the test holes.

SETTING

The following sections provide information about the geologic and climatic setting for the Site.

General Geology

The project area is located within the Cook Inlet Susitna Lowland subprovince of the Coastal Trough province of Alaska. The subprovince is characterized by glaciated lowland areas containing ground moraine, stagnant ice fields, drumlin fields, eskers, and outwash plains. The local relief is between 50 to 250 feet and the majority of the lowland is less than 500 feet above mean sea level (msl). Rolling upland areas rise to about 3,000 feet in altitude near the bordering mountain ranges. There are many irregular lakes and ponds in the area. The area is almost ice free and sporadic permafrost is present only in the northern portion of the subprovince (Wahrhaftig 1965).

Soils in the area are typically glacially derived sands and gravels and are typically overlain by a wind blown silt. Peat bogs are common in many low lying areas. Retreat of the glaciers formed the three major drainages of the area, the Knik, Matanuska, and Susitna rivers. The underlying bedrock generally consists of poorly consolidated coal-bearing rocks of tertiary age.

The project is located in a region of moderate seismicity and large-scale earthquakes may cause ground ruptures in some areas. Based on the United States Geologic Survey earthquake catalog, there were 112 events above Richter Magnitude 5 within 100 miles of the Site from 1899 through 2021, of which 28 exceeded Richter Magnitude 6.

Climatology

The project area is part of the transitional climate zone between the maritime climate of the southern coastal areas and the continental climate of interior Alaska. The zone is characterized by diurnal and annual temperature variations, moderate annual precipitation, and moderate surface winds. Average temperatures vary between lows of 5.5° Fahrenheit in January and highs of 67.1° Fahrenheit in July. Rainfall averages approximately 15.7 inches annually and is heaviest in August and September. Snowfall averages approximately 56 inches annually. Table 1 provides a summary of the climate data.

Table 1 – Summary of Climate Data

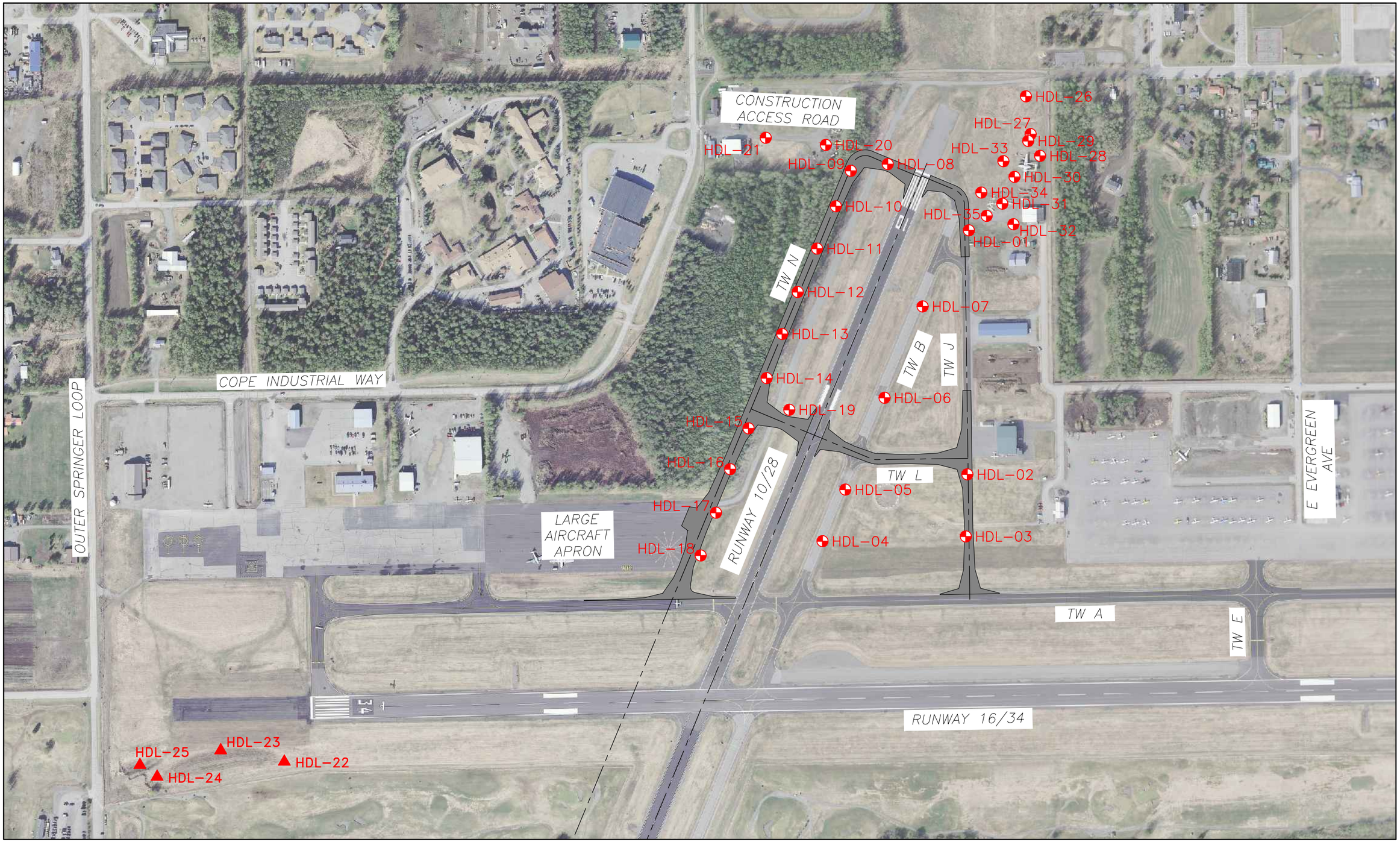
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Avg High. Temp (°F)	20.6	27.0	34.7	46.7	58.3	65.0	67.1	64.7	56.6	41.9	27.5	22.5	44.4
Avg Low. Temp (°F)	5.5	10.4	16.2	28.4	38.0	45.7	49.2	47.2	40.0	27.0	13.1	8.1	27.4
Avg Total Precip (in.)	0.91	0.83	0.72	0.47	0.67	1.31	2.06	2.36	2.45	1.52	1.26	1.15	15.73
Avg Total Snowfall (in.)	8.7	9.5	7.4	2.9	0.1	0.0	0.0	0.0	0.0	5.3	9.5	12.8	56.1

Palmer Job Corps, Alaska (506870) / Period of Record Monthly Climate Summary / Period of Record: 11/20/1948 through 12/31/2015 (Western Regional Climate Center, 2021)

SUBSURFACE EXPLORATION

HDL evaluated the subsurface conditions near the proposed improvements between November 3, 2021 and November 5, 2021. HDL developed an exploration plan using guidance from the Alaska Geotechnical Procedures Manual and Federal Aviation Administration Advisory Circular 150/5320-6G: Airport Pavement Design and Evaluation, modified to suit the project scope and location. The subsurface exploration consisted of twenty-one (21) borings, designated HDL-01 through HDL-21, and four (4) test pits, designated HDL-22 through HDL-25. On February 4, 2022, HDL evaluated the subsurface conditions near the proposed apron improvements. The subsurface exploration consisted of ten (10) borings, designated HDL-26 through HDL-35. The borings were located in the field using a handheld GPS and final locations were adjusted onsite due to access and obstructions. The maximum depth of the explorations was 17.0 feet below existing ground surface (bgs). Figure 2 shows the approximate boring and test pit locations.

Discovery Drilling, Inc mobilized a truck mounted CME 75 drill rig to perform the borings. Borings located within the existing Taxiway B embankment were performed using 3-inch outside diameter (O.D.) split spoons. Borings drilled greater than 4.0 feet bgs were performed using 3.25-inch inside diameter (I.D.) hollow stem augers. Split-spoon sampling was conducted in accordance with the Modified Penetration Test (MPT) procedure. In the Modified Penetration Test, samples are recovered by driving a 3-inch O.D. split-spoon sampler into the bottom of the advancing hole with blows of a 340-pound hammer free-falling 30 inches onto the drill rod. The number of blows required to advance the sampler the second and third 6-inch interval is termed the Penetration Resistance, designated as the "N-value". The N-value gives a measure of the relative density (compactness) or consistency (stiffness) of unfrozen cohesionless and cohesive soils, respectively. Split spoon samples were collected at 2.5 foot intervals in borings drilled greater than 4.0 feet bgs. The borings were backfilled with auger cuttings and pea gravel.



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LEGEND

HDL-01	BORING
HDL-22	TEST PIT

0 200 400
SCALE IN FEET

Figure 2
EXPLORATION LOCATION MAP
PALMER MUNICIPAL AIRPORT
CONSTRUCT TAXIWAY N AND
IMPROVE AIRPORT DRAINAGE
PALMER, AK

The City of Palmer Public Works department provided a John Deer 410E backhoe and operator to perform the test pits near the proposed infiltration gallery. Grab samples were collected at select intervals. Infiltration testing was conducted in HDL-25 in a 4-inch diameter standpipe with a final depth of approximately 2.0 feet bgs.

HDL performed fieldwork in general accordance with the procedures outlined in the DOT&PF "Alaska Geotechnical Procedures Manual". Infiltration testing was performed in general accordance with the Environmental Protection Agency's "Falling Head Percolation Test Procedure". An experienced HDL engineering assistant located the borings and test pits, collected samples, logged subsurface conditions, observed groundwater depths, where encountered, and performed infiltration testing. We described the subsurface conditions in accordance with the following methods and standards:

- ASTM International Standard (ASTM) D2488 for field description of soils;
- Frost Design Soil Classification using the DOT&PF methodology; and,
- Unified Soil Classification System (ASTM D2487) to confirm or modify soil classifications based on laboratory test results.

The Boring Log Key and Frost Design Soil Classification Key are in Appendix C. Boring logs and test pit logs are attached in Appendix D.

LABORATORY TESTING

HDL conducted the following laboratory tests on select soil samples at our AASHTO accredited and United States Army Corp of Engineers validated laboratory:

- One hundred and forty-eight (148) natural moisture content tests (ASTM D 2216);
- Forty-one (41) grain size distribution tests (ASTM D 422); and,
- Ten (10) organic content tests (ASTM D 2974).

After testing, the remaining samples were stored at HDL's laboratory. Sample test results are provided on the boring and test pit logs in Appendix D and the grain-size distribution curves in Appendix E. Figures 3, 4, and 5 provide a summary of the moisture content results.

SUBSURFACE CONDITIONS

In general, the borings and test pits encountered an organic mat underlain by sandy silt with varying amounts of gravel and organics. Sand and gravel with varying amounts of silt were encountered below the near surface sandy silt and were present to the termination depths.

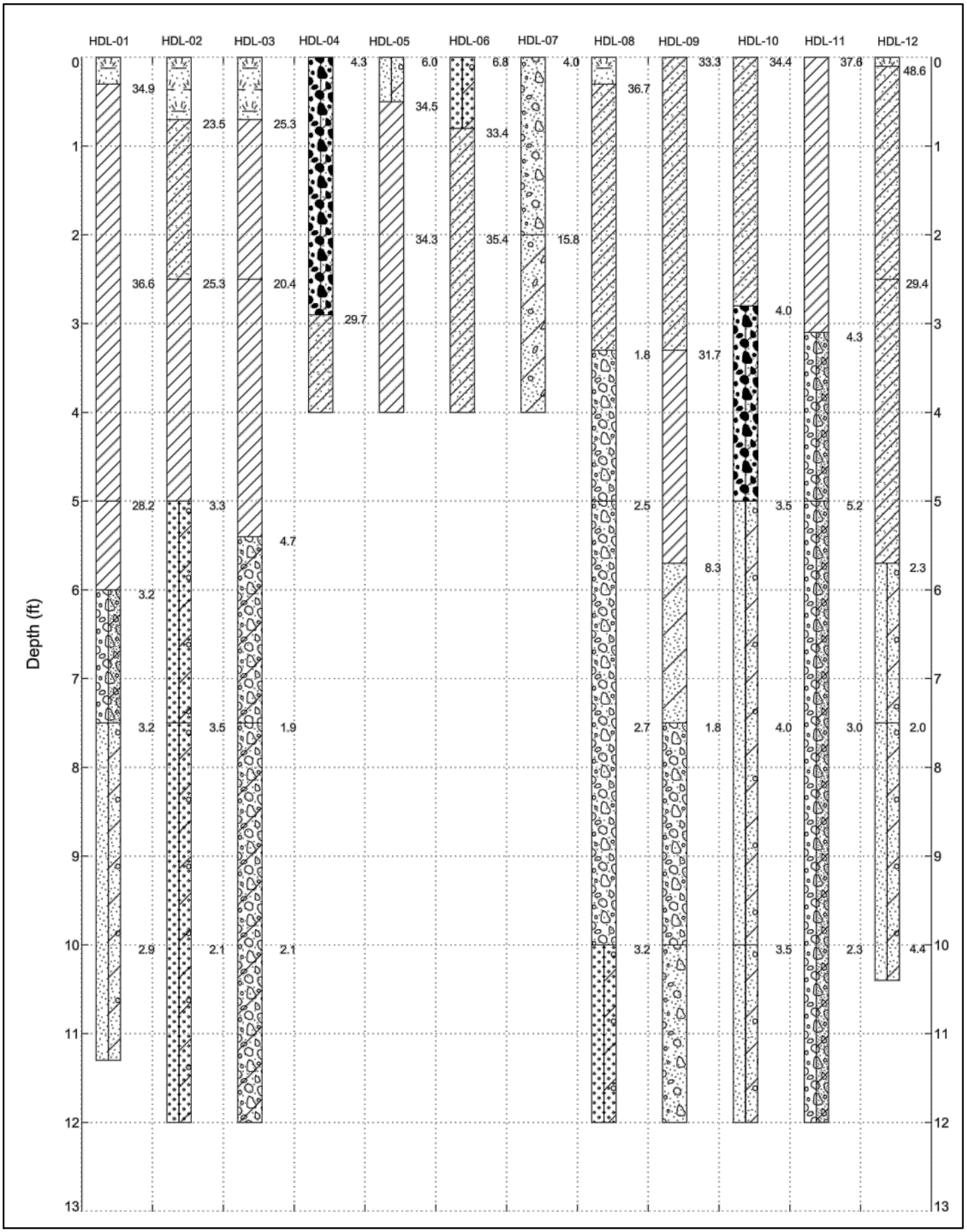

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Figure 3
MOISTURE CONTENT SUMMARY
PALMER MUNICIPAL AIRPORT
CONSTRUCT TAXIWAY N AND
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PALMER, AK

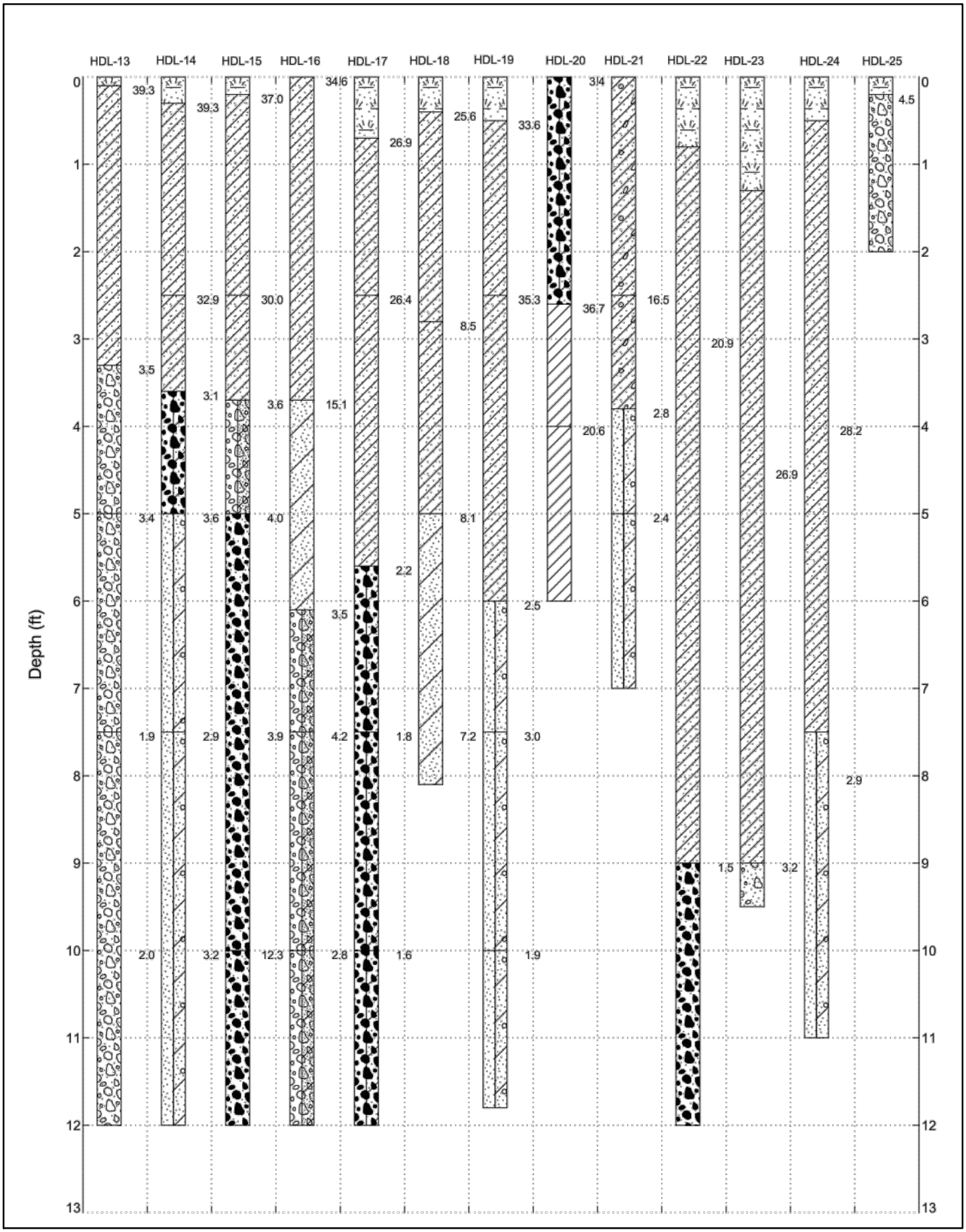

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Figure 4
MOISTURE CONTENT SUMMARY
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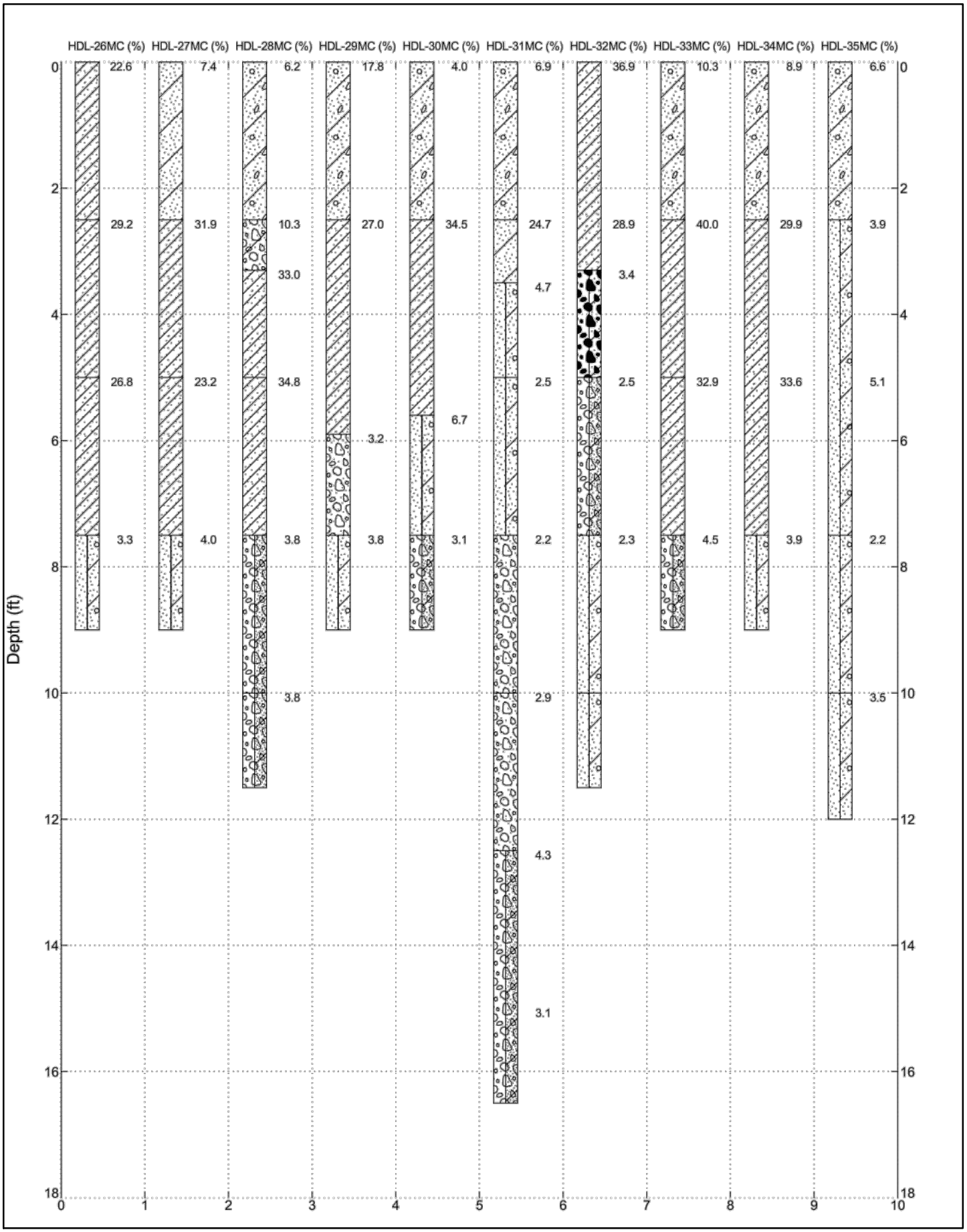

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Figure 5
MOISTURE CONTENT SUMMARY
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Organic Mat & Topsoil

An organic mat was encountered at the surface in HDL-01 through HDL-03, HDL-08, HDL-12 through HDL-15, HDL-17 through HDL-19, and HDL-22 through HDL-25. The organic mat and topsoil layer ranged in thickness from approximately 0.1 feet thick to approximately 1.3 feet thick. Detailed information may be found on the logs presented in Appendix D.

Silt

Silt with varying amounts of sand, gravel, and organics was encountered at the surface or beneath the organic mat, when present, in borings and test pits performed off of existing embankments. Silt was generally encountered beneath the structural section where embankments were present. The silt layer ranged in thickness from 2.8 feet to 8.2 feet thick. Table 2 summarizes the laboratory results for this stratum.

Table 2 – Silt Laboratory Results Summary

Test Hole	Depth	Grain Size Distribution		
	(ft)	% Gravel	% Sand	% P200
HDL-01	2.5	2.1	13.5	84.4
HDL-02	2.5	0.0	12.5	87.5
HDL-03	2.5	0.1	14.0	85.9
HDL-05	0.5	0.0	10.9	89.1
HDL-06	0.8	7.4	19.0	73.6
HDL-09	3.3	0.0	11.8	88.2
HDL-12	2.5	0.0	26.1	73.9
HDL-14	2.5	1.6	17.1	81.3
HDL-15	2.5	0.0	18.9	81.1
HDL-17	2.5	0.4	26.7	72.9
HDL-18	2.8	0.6	13.4	86.0
HDL-19	2.5	0.0	16.6	83.4
HDL-20	2.6	0.6	8.8	90.6

Silty Sand

A silty sand layer that was interpreted to be fill was encountered at the surface in HDL-27 through HDL-31 and HDL-33 through HDL-35. This layer generally extended from the existing ground surface to depths ranging from 2.5 feet to 3.5 feet bgs. Table 3 summarizes the laboratory results for this stratum.

Table 3 – Silty Sand Laboratory Results Summary

Test Hole	Depth	Grain Size Distribution		
	(ft)	% Gravel	% Sand	% P200
HDL-27	0.0	25.5	59.8	14.7
HDL-28	0.0	27.9	54.6	17.5
HDL-29	0.0	30.0	42.5	27.5
HDL-30	0.0	20.2	58.8	21.0
HDL-31	0.0	19.4	61.7	18.9
HDL-33	0.0	26.1	53.6	20.3
HDL-35	0.0	30.8	54.9	14.3

Native Sand and Gravel

Native sand and gravel with varying amounts of silt and cobbles were encountered beneath the silt layer and generally extended to the boring and test pit termination depth. Table 4 summarizes the laboratory results for this stratum.

Table 4 – Native Sand and Gravel Laboratory Results Summary

Test Hole	Depth	Grain Size Distribution		
	(ft)	% Gravel	% Sand	% P200
HDL-02	7.5	42.2	47.6	10.2
HDL-03	5.4	47.1	39.1	13.8
HDL-08	3.3	53.8	42.8	3.4
HDL-08	10.0	36.8	55.5	7.7
HDL-09	5.7	14.7	67.2	18.1
HDL-10	2.8	61.2	32.8	6.0
HDL-11	3.1	56.2	38.2	5.6
HDL-13	3.3	58.2	37.4	4.4
HDL-14	3.7	65.9	27.9	6.2
HDL-15	5.0	52.5	44.6	2.9
HDL-16	3.7	1.8	72.2	26.0
HDL-17	10	55.3	38.2	6.5
HDL-22	9.0	66.9	32.1	1.0
HDL-25	0.2	52.5	44.4	3.1
HDL-29	5.9	71.3	24.6	4.1
HDL-32	3.3	50.6	38.7	10.7

Granular Fill

Granular soils, interpreted to be fill, consisting of sand and gravel with varying amounts of silt, was encountered at the surface in borings performed in the Taxiway B shoulders and near the proposed construction access road. The granular fill ranged in thickness from 0.5 feet to greater than 4.0 feet. Table 5 summarizes the laboratory results for this stratum.

Table 5 – Granular Fill Laboratory Results Summary

Test Hole	Depth	Grain Size Distribution		
	(ft)	% Gravel	% Sand	% P200
HDL-04	0.0	46.9	45.4	7.7
HDL-06	0.0	39.9	52.7	7.4
HDL-07	0.0	41.2	54.0	4.8
HDL-20	0.0	55.1	38.1	6.8
HDL-21	2.5	16.7	38.0	45.3

Groundwater

Free groundwater was not encountered in the borings or test pits. Groundwater levels at the Site may fluctuate depending on the season, temperature, and precipitation. Groundwater levels during construction may be higher or lower than those encountered.

Infiltration Testing

HDL performed infiltration testing in the native sand and gravel in HDL-25, near the proposed drainage improvements. Infiltration testing was conducted in a 4-inch diameter standpipe installed to a final depth of approximately 2.0 feet bgs. Per the Falling Head Percolation Test Procedure, the last measurement taken is used to calculate the infiltration rate. Based on the last measurement, the calculated infiltration rate was 0.14 minutes per inch. Based on the subsurface conditions observed, we would expect the infiltration test results to be representative of the native sand and gravel along the length of the proposed drainage improvements.

ENGINEERING ANALYSIS AND RECOMMENDATIONS

A summary of the geotechnical considerations and recommendations are provided below.

Site Preparation and Fill

HDL recommends the Site be cleared of vegetation, the organic mat, and deleterious materials. Existing pavement on Taxiway B should be milled or removed and crushed/pulverized to meet the requirements of Item P-161 Recycled Asphalt Pavement. We recommend the exposed subgrade be proof-rolled to provide a level, firm, uniform, and unyielding surface prior to the placement of fill. Fill placed on the Site should be placed and compacted in accordance with

DOT&PF Standard Specifications for Airport Construction (Standard Specifications).

Fill placed below the structural section should consist of mineral soil that is free of debris, ice, excess moisture, and other deleterious materials, and meet Suitable Material requirements for P-152, Excavation, Subgrade, and Embankment.

Pavement Design

HDL developed pavement recommendations based on the following design standards, design criteria, and inputs:

- Federal Aviation Administration Advisory Circular 150/5320-6G;
- FAARFIELD V2.0 software (example provided in Appendix G);
- Geotechnical Data;
- Fleet mix for PAQ (provided in Appendix F); and,
- 20-year design life;

HDL used the Limited Subgrade Frost Penetration design procedure, which requires 65% of the frost penetration to be composed of non-frost susceptible material, for design of the pavement structural section. Based on the work previously conducted at the airport by HDL, a minimum structural section of 54 inches is recommended for the proposed taxiways and a minimum structural section of 42 inches is recommended for Apron E.

Taxiway N will be designed to serve all aircraft at PAQ. The minimum recommended structural section for Taxiway N is as follows:

4 inches	Asphalt Pavement (Item P-401 Type II, Class A)
6 inches	Crushed Aggregate Base Course (Item P-209)
6 inches	Subbase Course (Item P-154)
38 inches	Embankment (Item P-152)

Assuming Taxiway J only serves aircraft weighing less than 60,000 pounds, the minimum recommended structural section for the Taxiway J extensions is as follows:

3 inches	Asphalt Pavement (Item P-401 Type II, Class B)
6 inches	Crushed Aggregate Base Course (Item P-209)
6 inches	Subbase Course (Item P-154)
39 inches	Embankment (Item P-152)

Assuming Apron E will primarily serve aircraft weighing less than 4,000 pounds with some aircraft weighing up to 25,000 pounds, the minimum recommended structural section for Apron E is as follows:

3 inches	Asphalt Pavement (Item P-401 Type II, Class B)
4 inches	Crushed Aggregate Base Course (Item P-209)
6 inches	Subbase Course (Item P-154)
29 inches	Embankment (Item P-152)

The total structural section assumes silt will be present at the bottom of the excavation. The thickness of Embankment (Item P-152) may be reduced if the native sand and gravel is encountered within the proposed structural section, with approval from the geotechnical engineer. We do not recommend removing and replacing the native sand and gravel with Embankment.

Granular material, generally consisting of silty sand, was encountered at the ground surface near the proposed apron E area. This material does not meet the requirements of Item P-152 and should not be used within the pavement structural section.

HMA pavement should be placed and compacted in accordance with the Standard Specifications. HMA pavement should meet the requirements of Item P-401 Plant Hot Mix Asphalt Pavement. Crushed Aggregate Base Course and Subbase Course should meet the requirements of Item P-209 and Item P-154, respectively, and be placed and compacted in accordance with the Standard Specifications. Embankment material should meet the Suitable Material requirements for P-152, Excavation, Subgrade, and Embankment. Item P-152 should be placed and compacted in accordance with the Standard Specifications.

The recommended structural sections do not provide full frost protection and seasonal movement of the pavement should be expected. This movement may reduce the life of the pavement; however, we do not anticipate significant differential movement to be realized. The life of the pavement can be increased by increasing the thickness of the structural section.

Shoulder Surfacing

The taxiway shoulders should be surfaced with a minimum of 4 inches of RAP (Item P-161) or Crushed Aggregate Base Course (Item P-209).

Construction Access Road

The proposed construction access road will provide access for heavy construction equipment for the duration of construction. We understand the existing alignment is surfaced with gravel but has several low areas and soft spots. We recommend excavating approximately 2 feet of material and replacing it with compacted fill. The exposed subgrade should be proof-rolled to provide a level, firm, uniform, and unyielding surface prior to the placement of fill. The minimum recommended structural section for the proposed construction access road is as follows:

6 inches	Crushed Aggregate Base Course (Item P-209) or Recycled Asphalt Pavement (Item P-161)
6 inches	Subbase course (Item P-154)
12 inches	Embankment (Item P-152)
P-681	Geotextile for Separation

The geotextile should meet the requirements of Item P-681 for separation and be placed according to the Standard Specifications. Crushed Aggregate Base Course, Recycled Asphalt

Pavement, and Subbase Course should meet the requirements of Item P-209, Item P-161, and Item P-154, respectively, and be placed and compacted in accordance with the Standard Specifications. Embankment material should meet the Suitable Material requirements for P-152, Excavation, Subgrade, and Embankment. Item P-152 should be placed and compacted in accordance with the Standard Specifications.

Apron Tiedowns

Tiedowns on Apron E should meet the requirements indicated in Item P-650, Aircraft Tie-Down of the Standard Specifications.

Frost Susceptibility

Palmer is in a region of moderate freeze and thaw cycles. Soils throughout the project were typically non- to highly-frost susceptible (NFS to F4). Highly frost susceptible soils were encountered within the shallow subsurface at the Site. Leaving the highly frost susceptible soils in place increases the risk of frost related issues. The recommended structural sections do not provide full frost protection and seasonal movement of the pavement should be expected. This movement may reduce the life of the pavement. The life of the pavement can be increased by increasing the thickness of the structural section.

Drainage and Dewatering

Free groundwater was not encountered during drilling. Groundwater is not likely to be encountered during typical site preparation work, but the groundwater level will likely vary from that encountered during drilling. HDL recommends the site be graded to promote positive drainage away from the paved surfaces and compaction of the near surface soils to reduce permeability.

Reuse of Existing Soils

The existing organic mat, topsoil, and sandy silt may not be used within the proposed taxiway and construction access road embankments. The organic mat and topsoil may be used as topsoil and the sandy silt may be used as fill in the infield areas.

The granular fill encountered in the borings at the surface of the proposed construction access road, within the Taxiway B embankment generally meets the Suitable Material requirements for P-152 and may be used at the bottom of the structural section for the Taxiway J extensions. Additional laboratory testing should be performed during construction to confirm the material meets the requirements of P-152 prior to reuse.

The granular fill encountered in the borings near the surface of a portion of the Apron E area does not meet the Suitable Material Requirements for Item P-152 and may not be used within the pavement structural section. This granular material may be used outside the pavement structural sections as fill.

RAP may be used to surface the taxiway shoulders or proposed construction access road as detailed in the previous sections.

Construction Considerations

Silt and silt-rich soils will be exposed in the subgrade during construction and will be difficult to moisture condition and compact. It is recommended that exposure of the subgrade be limited to maintain the integrity of the subgrade. The contractor should be prepared for challenges during construction if the subgrade soils get wet.

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CLOSURE

This Report has been prepared at the request and authorization of the City of Palmer and is subject to the Limitations provided in Appendix A. Please feel free to contact Jeremy Dvorak at jdvorak@hdlalaska.com or (907)564-2120 for questions or clarifications.

Appendix A

Limitations

GEOTECHNICAL LIMITATIONS

Use of Report

1. HDL Engineering Consultants, LLC (HDL) prepared this report on behalf of, and for the exclusive use of our Client for the stated purpose(s) and location(s) identified in the Proposal for Services and/or Report. Use of this report, in whole or in part, at other locations, or for other purposes, may lead to inappropriate conclusions; and we do not accept any responsibility for the consequences of such use(s). Further, reliance by any party not expressly identified in the agreement, for any use, without our prior written permission, shall be at that party's sole risk, and without any liability to HDL.

2. If substantial time has elapsed between submission of this report and the start of work at the site, or if conditions have changed because of natural causes or construction operations at or adjacent to the site, we recommend that HDL be retained to review this report to determine the applicability of the conclusions considering the time lapse or changed conditions.

Standard of Care

3. HDL's findings and conclusions are based on the work conducted as part of the Scope of Services set forth in the Proposal for Services and/or Report, and reflect our professional judgment. These findings and conclusions must be considered not as scientific or engineering certainties, but rather as our professional opinions concerning the limited data gathered during the course of our work. If conditions other than those described in this report are found at the subject location(s), or the design has been altered in any way, HDL shall be so notified and afforded the opportunity to revise the report, as appropriate, to reflect the unanticipated changed conditions.

4. HDL's services were performed using the degree of skill and care ordinarily exercised by qualified professionals performing the same type of services, at the same time, under similar conditions, at the same or a similar property. No warranty, expressed or implied, is made.

Subsurface Conditions

5. The generalized soil profile(s) provided in our Report are based on widely-spaced subsurface explorations and are intended only to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized, and were based on our assessment of subsurface conditions. The composition of strata, and the transitions between strata, may be more variable and more complex than indicated. For more specific information on soil conditions at a specific location refer to the exploration logs.

6. Unanticipated soil conditions are commonly encountered and cannot be fully determined by merely taking soil samples or advancing borings. Such unexpected conditions frequently require additional expenditure to attain a properly constructed project. Therefore, some contingency fund is recommended to accommodate such potential extra costs.

7. In preparing this report, HDL relied on certain information provided by the Client, state

and local officials, and other parties referenced therein which were made available to HDL at the time of our evaluation. HDL did not attempt to independently verify the accuracy or completeness of all information reviewed or received during the course of this evaluation.

8. Water level readings have been made in test holes (as described in the Report) and monitoring wells at the specified times and under the stated conditions. These data have been reviewed and interpretations have been made in this Report. Fluctuations in the level of the groundwater occur due to temporal or spatial variations in areal recharge rates, soil heterogeneities, the presence of subsurface utilities, and/or natural or artificially induced perturbations. The water encountered in the course of the work may differ from that indicated in the Report.

9. HDL's services did not include an assessment of the presence of oil or hazardous materials at the property. Consequently, we did not consider the potential impacts (if any) that contaminants in soil or groundwater may have on construction activities, or the use of structures on the property.

10. Recommendations for foundation drainage, waterproofing, and moisture control address the conventional geotechnical engineering aspects of seepage control. These recommendations may not preclude an environment that allows the infestation of mold or other biological pollutants.

Compliance with Codes and Regulations

11. We used reasonable care in identifying and interpreting applicable codes and regulations. These codes and regulations are subject to various, and possibly contradictory, interpretations. Compliance with codes and regulations by other parties is beyond our control.

Additional Services

12. HDL recommends that we be retained to provide services during any future: site observations, design, implementation activities, construction and/or property development/redevelopment. This will allow us the opportunity to: i) observe conditions and compliance with our design concepts and opinions; ii) allow for changes in the event that conditions are other than anticipated; iii) provide modifications to our design; and iv) assess the consequences of changes in technologies and/or regulations.

Appendix B

Previous Geotechnical Studies

(Arranged in Chronological Order)

November 30, 2005

Prepared by:

M. Dale Butikofer, E.I.T.
Staff Engineer

Reviewed by:

Lorie M. Dilley, P.E./C.P.G.
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COMMERCIAL APRON REHABILITATION
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1.0 INTRODUCTION

This report presents the results of subsurface explorations, laboratory testing, and geotechnical engineering studies for the rehabilitation of Runway 9-27, the associated taxiway (Taxiway B), and the commercial apron located at the Palmer Municipal Airport in Palmer, Alaska. The purpose of the field exploration was to define the soil and groundwater conditions for use in the design of the improvements to the airport. To develop the criteria for use in design, seventeen borings were advanced within the proposed improvement areas. Soil samples recovered from the borings were classified in the field and returned to our laboratory for testing and verification. Based on the field observations and laboratory results, engineering studies were conducted to develop our design recommendations. Included in this report are a description of the site and project, subsurface explorations and laboratory test procedures, interpretation of the subsurface conditions and conclusions, and recommendations from our engineering studies.

2.0 SITE AND PROJECT DESCRIPTION

The project is located at the municipal airport in Palmer Alaska. Palmer is located 42 miles northeast of Anchorage along the Glenn Highway. Figure 1 presents a vicinity map and Figure 2 presents a project site map. Palmer lies on the outwash plain of the Matanuska and Knik Glaciers. Thick deposits of sand and gravel are a result of past glacial activity and stream deposition. These deposits are mantled by loess (wind blown silt) throughout Palmer.

The project will consist of rehabilitating the approximately 4,000 foot long runway and Taxiway B. The pavement section for Runway 9/27 and Taxiway B is based on B-II aircraft. A Beech Super King Air is the design B-11 aircraft which has a maximum take off weight of 12,500 pounds. Although larger aircraft are stationed at the airport, they are restricted from using Runway 9/27 and Taxiway B.

The commercial apron located on the southern end of the airport will also be extended to the north by approximately 243,000 square feet. The commercial apron's pavement

section is based on B-III aircraft. A DC-6 is the design B-III aircraft which has a maximum take off weight of 104,000 pounds.

The structural section designs for the runway, taxiway, and apron follows FAA circular AC 150/5320-6D and is based on determining the California Bearing Ratio (CBR) for the soils. The section based on the supporting soils CBR is then checked against frost penetration and the section is thickened if appropriate. The thicker section is then chosen as the design section for each facility.

3.0 FIELD EXPLORATIONS

Seventeen borings, designated Boring BH-1 through BH-17, were advanced at the site on the 21st and 22nd of September, 2005. The locations of these borings are shown on Figure 2. Locations of the borings were based on location of pavement degradation along both the runway and taxiway, and accessibility. Discovery Drilling Inc. of Anchorage, Alaska provided drilling services for this project using a CME 75 drill rig with 3 ½-inch hollow stem auger and a three-inch outside diameter (O.D.) split spoon sampler. An experienced engineer from our firm was present continuously during drilling to locate the borings, observe drill action, collect samples, log subsurface conditions, and monitor any groundwater encountered. The soils were classified according to the Unified Soil Classification System presented in Appendix A, Figure A-1. Frost classifications were assigned to the soils according to the classification presented in Appendix A, Figure A-2. Detailed logs of the borings are presented in Appendix A, Figures A-3 through A-19.

The borings were advanced to nominal depth of 15 feet. One boring, BH-10 encountered auger refusal at 14 feet. Cobbles and boulders are common in the deeper, glacially deposited soil. In each of the borings, split-spoon samples were collected at 2.5-foot intervals from the surface to and including 5 feet in depth, and then at 10 and 15 feet in depth. Sampling with the split-spoon was conducted using the Modified Penetration Test procedure. In the Modified Penetration Test, samples are recovered by driving a 3-inch O.D. split spoon sampler into the bottom of the advancing hole with blows of a 340-lb. hammer free-falling 30 inches onto the drill rod. The number of blows required to advance the sampler the final 12 inches of an 18-inch penetration in the test is termed the Penetration Resistance, which was recorded for each sample depth. The values give a measure of the relative density (compactness) or consistency (stiffness) of cohesionless or cohesive soils, respectively.

4.0 LABORATORY TESTING

Laboratory tests were performed on selected samples recovered from the borings to verify field classifications. The laboratory testing was formulated with emphasis on determining the materials classification, moisture, and frost characteristics. This data, along with estimated strength and density properties, provided information for developing the structural section. The soils were classified in the field and later confirmed from laboratory testing. The Municipality of Anchorage (MOA) frost classification, presented in Figure A-2, Appendix A was used to estimate the frost characteristics of the soils based on the laboratory results.

A total of 100 water content tests were performed on samples from the seventeen borings. The results or the water content test provide an estimate on saturation. These tests were conducted in accordance with procedures described in ASTM D-2216. The results of the water content measurements are presented on the boring logs, in Appendix A, Figures A3 through A19.

Grain size classification tests for this project consisted of ten mechanical sieve tests and thirteen P200 tests. The results were used to estimate permeability characteristics and frost susceptibility of the soils. The mechanical sieve tests were conducted according to procedures described in ASTM D-422. The results of the mechanical sieves are presented in Appendix A, Figures A-20 through A-21, and on the bore logs in Appendix A, Figures A3 through A19. The P200 tests were conducted according to procedures described in ASTM D-1140. The results of the P200 tests are presented on the bore logs in Appendix A, Figures A3 through A19.

5.0 SUBSURFACE CONDITIONS

The soils at the Palmer Airport are glacialfluvial in origin. Two main soil types exist at the Palmer Airport, a cobbly, sandy gravel (stream/glacial deposits), and a sandy silt (loess). The coarse-grain soil was deposited as glaciers receded and the rivers developed. Sediment was transported by the melt water via large braided streams; the Matanuska and Knik Rivers. The Matanuska River and the Knik River were and still are fed by glaciers, which produce tremendous volumes of sediment particularly sand and gravel. Windblown sediment from the glacial river floodplain created the loess. Loess deposits which mantle the sands and gravels, developed as the rivers and glaciers decreased to their present day extent.

The subsurface conditions at the sites are depicted on the profile in Figures 3 through 12 and in the boring logs presented in Appendix A, Figures A3 through A19. The soils

encountered were generally gravelly sand and sandy gravel overlain by silt with varying amounts of sand, gravel, and organics. The silt deposits were overlain by a structural section at the runway and taxiway. Auger refusal (Boring BH-10) and sample refusal (Borings BH-2, BH-6, BH-7, BH-9 and BH-12) indicate cobbles and boulders are present in the sands and gravels.

Groundwater was not encountered in any of the borings. Groundwater depths in the area are generally quite deep, at about 100 feet. The Matanuska River, which would supply the groundwater system in the immediate vicinity, is approximately 50 feet below the current ground elevation. Seasonal fluctuations in the groundwater table may occur due to variations in snowfall, rainfall, and temperature. Due to the relatively level nature of the surface, we do not expect the groundwater table to vary more than a few feet throughout the year.

5.1 Runway and Taxiway

Borings BH-1 through BH-14 were advanced on Runway 9/27 and Taxiway B. The subsurface profiles for Runway 9/27 are presented in Figures 3 through 7, and for Taxiway B in Figures 8 through 12. The borings encountered a structural section of slightly silty, sandy gravel that varied in thickness from 1.7 to 2.7 feet. Grain size analyzes indicated fines contents ranging from 5.9 to 18.5 percent classifying the section soils as non to moderately frost susceptible (NFS to F2). Moisture contents below 5 percent indicate dry conditions Blow counts indicated densities of loose to medium dense in this layer.

A layer of sandy silt (loess) was encounter in the borings immediately below the structural section. Thickness of the silt layer was about 2.5 inches in Boring BH-9 to varying from about 2 to 9.5 feet thick in the remaining borings. The loess density varied greatly from very soft to stiff, though some of the higher blow counts may have been influenced by underlying gravel layers. Moisture contents ranged from 15 to 38 percent. Below about 30 percent moisture content, silts are on the dry side of optimum. Sand contents ranged from 18 to 44 percent. The frost classification for all of silts encountered is F4 highly frost susceptible.

Underlying the silts was a medium dense to very dense layer of sandy gravel with trace to slight amounts of fines. This layer continued to the depth of borings. Fines content was typically less than 5 percent. A layer of silty, sandy gravel was encountered at Boring BH-2 from15 feet to boring completion. Based on sample refusals cobbles/boulders occur in this layer and are probably about 10 to 20 percent of the soil. The sands and gravels are non-frost susceptible (NFS). Moisture contents generally ranged from approximately 1 to 4 percent.

5.2 Commercial Apron

Borings BH-15 through BH-17 were advanced in the area of the proposed commercial apron expansion. The surface consisted of tall grasses and about a 6-inch organic root mat, underlain by sandy silt with organics. The silt layer was approximately 5 to 6.5 feet deep. The consistency of this layer was soft. Moistures ranged from 24 to 50 percent at the surface, the organics increase the moisture content, and 11 to 15 percent at 2.5 feet. Fines content ranged from 65 to 85 percent.

At Boring BH-15, silty, sandy gravel with 13.4 percent fines and a frost classification of F2 was encountered from 5 to 10 feet. All other samples recovered underlying the loess layer were sandy gravel with trace silt to slightly silty, sandy gravel. This soil occurred to the depth of the boring. Moistures ranged from 1.7 to 2.3 percent, which is slightly dry of optimum.

6.0 CLIMATOLOGY

Palmer is located in a transitional climatic zone near the confluence of the Matanuska River and Knik River. The zone is characterized by moderate diurnal and annual temperature variations, moderate annual precipitation, and strong surface winds. The Environmental Atlas of Alaska and the Alaska Department of Community and Economic Development provided the following information used for this project:

Mean Annual Temperature	36 ^{0}F
Mean Annual Precipitation	16.5 in.
Mean Annual Snowfall	50 in.
Thawing Index	3000 degree days
Freezing Index	2250 degree days
Seasonal Lag	21 days

Winds for the Palmer area are generally from the east and north coming from the Knik River Valley and the Matanuska River Valley. Design wind loads for the area are 40 psf. Design snow loads for the area are 40 psf.

7.0 ENGINEERING ANALYSIS & RECOMMENDATIONS

The design of the structural sections for the runway, taxiway, and commercial apron require an understanding of the strength of the underlying soils, frost-susceptibility, the climate influencing the frost penetration, and the design aircraft load. There are three

acceptable design methodologies: the California Bearing Ratio (CBR), the FAA Soil Group, and the Asphalt Pavement Institute model. The CBR method and FAA soil group are used by the FAA circular AC 150/5320-6D. As part of the CBR method, the frost characteristics of the soils are analyzed using two different procedures for highly frost susceptible F4 soils: the Complete Protection procedure and the Limited Subgrade Frost Penetration procedure. A third method, the Reduced Subgrade Strength Method, is applicable to slightly to moderately frost susceptible F1 to F3 soils. The loess underlying the existing structural section is a highly frost susceptible, F4, soil.

CBR values are related to the density of the soils. CBRs are not typically directly obtained in the field due to the cost and size of the specialized equipment needed. The CBR values used in this design were estimated based on the fines content, the moisture contents, the unit weight of the soils, and the field engineer's estimate of soil densities at the time of drilling.

Based on the silt (loess) characteristics, an estimated CBR value of 10 was used for design of the structural section. This value assumes that all soft organics and organic rich silts will be removed.

To accommodate frost penetration into the subsurface, the sections developed based on CBR value were checked for frost using the Complete Protection procedure and the Limited Subgrade Frost Penetration procedure. The Complete Protection procedure is used when frost heaving can not be tolerated and results in a structural section of 80 to 110 inches of non-frost susceptible material. This method is used typically when the section will be paved and large/heavy aircraft are the design aircraft. The Limited Subgrade Frost Penetration procedure is based on the theory of holding frost heave to a tolerable level by designing the non-frost susceptible (NFS) structural section to sixty five percent (65%) of the depth of frost penetration.

7.1 Runway and Taxiway

The pavement section for Runway 9/27 and Taxiway B is based on B-II aircraft with a Beech Super King Air as the design aircraft having a maximum take off weight of 12,500 pounds. Using a CBR of 10, this produces a structural section of 8 inches comprised of 2 inches asphalt cement pavement, 3 inches base course, and 3 inches subbase.

Since the runway and taxiway are not handling large/heavy aircraft, the Limited Subgrade Frost Penetration procedure instead of the Complete Protection procedure was used to check the structural section of 8 inches for frost penetration. Runway 9/27 handles light-load aircraft at high speeds and will therefore need to be designed to a higher standard than the taxiway, decreasing the likelihood of movement due to heaving.

Two alternative structural sections are presented in Table 1. Alternative A is based on constructing the runway on the loess. Using the Limited Subgrade Frost Penetration procedure this produces a 54-inch structural section. Alternative B is based on excavating all the loess and constructing the section on the native sand and gravel. This produced a structural section of 48 to 136 inches thick depending upon the thickness of the loess.

Table 1 – Recommended Structural Sections

Material Type	*Layer Thickness (in.)*		
	Runway (Alternative A)	*Runway (Alternative B)*	*Taxiway*
Asphalt	3	2	2
Base	6	6	4
Subbase	45	40-130	36
Total	*54*	*48-138*	*42*

If the runway is reconstructed according to Alternative A, there is a possibility of some movement in late winter and early spring. Differential settlement may be a problem due to variable depths of the silt (F4). If constructed according to Alternative B, the runway will rest on the native sandy gravels (NFS to F2). The life of the runway will be extended due to its structural integrity.

The taxiway handles light-load aircraft, but at much lower speeds than the runway. More movement due to heaving can be tolerated. Long term performance of the pavement along other aprons and taxiways at the airport has been good. These have been constructed with 2 inches of asphalt, 4 inches of base course, and 36 inches of subbase. Table 1 presents the taxiway structural section.

In order to minimize differential settlement between the above sections and the cross-runway section or other taxiways that intersect the proposed taxiway and runway reconstruction, the above sections should be feathered into the existing sections. The existing sections should be excavated at a slope of about 45 degrees and the above sections created over this excavation with the subbase layer diminishing in thickness within the original runway section. When placing the asphalt, care should be taken to overlap joints and create water tight seals.

7.2 Commercial Apron

The commercial apron's pavement section is based on B-III aircraft with a DC-6 as the design aircraft with a maximum take off weight of 104,000 pounds. Using a CBR of 10 for the loess, the overall thickness of the apron structural section is 30 inches including 4 inches of asphalt, 6 inches of base course, and 20 inches of subbase.

The commercial apron will be expanded to handle medium to heavy-load aircraft. It will, however, be used at low speeds; therefore, some movement can be tolerated. We checked the above apron structural section against the Limited Subgrade Frost Penetration procedure. The recommended structural section is presented in Table 2.

Table 2 – Recommended Structural Section

Material Type	*Layer Thickness (in.)* *Limited Subgrade*
Asphalt	4
Base	6
Subbase	48
Total	*58*

7.3 Quality Control

The subbase soils below the paved areas should be placed as uniform as possible. The subgrade surface should be sloped to direct drainage away from the pavement section. By controlling the water that reaches the subgrade, internal seasonal movements within the section will be limited with the result being less total heave and an extended pavement life.

The performance of the pavement is controlled by the details of construction, and by the quality of the materials that will be imported to the site, placed, and compacted to develop the needed structural section. Quality control inspection is strongly recommended with support soil and asphalt testing at regular intervals to be sure that the intent of the specification is met.

7.4 Drainage

Groundwater was not encountered in the borings. To provide further product protection regardless of the option chosen, we recommend that the surface be designed to encourage surface water flow to the edges, catch basins, and to a collection system and away from the highly frost susceptible soils.

7.5 Fill and Compaction

Imported fill to bring the site to proper grade or to construct the pavement section should be granular and consist of a reasonably well graded mixture of sand and gravel. The

subbase should meet the gradation requirements for the City of Palmer Type IIA as shown in Figure 13. The existing structural section of 1.7 to 2.7 feet can be re-used in the base of the excavation. The existing structural section from the runway and taxiway typically are NFS except for local pockets up to 10 to 18 percent fines. All of the soils in the existing structural sections can be re-used from the base of excavation up to about 48 inches below the finished grade. The existing asphalt can be rotomilled, stockpiled and reused in the base of excavation, if it can be compacted to 95 percent of maximum dry density.

The base course should meet the gradation requirements of City of Palmer, Leveling Course presented in Figure 13. All fills within the pavement sections should be placed in lifts not exceeding 12-inches in loose thickness and compacted to a percentage of the Modified Proctor Density as specified in Table 3. The Modified Proctor Density is determined using ASTM test method D-1557.

Table 3 – Compaction Requirements

Material Type	*Recommended Compaction*
Asphalt	Per FAA Specifications
Base	100 %
Subbase	95 %

The subgrade material is loess in origin. Loess has been wind deposited with particles in “loose” position, but has developed some “structure” that gives it a degree of strength. When undisturbed, it is stiff and can have much greater strength than the same soil when disturbed. Attempts to compact the silt when the moisture is too high will cause it to weaken and pump. For this reason, it is recommended that the base and subbase be compacted as specified, and the subgrade be left undisturbed. Compaction of the subbase and base should not be attempted in the spring while the silt subgrade is still thawing.

If during compaction of the first lift of subbase over the silts drives the granular material into the silts, a separation blanket may be needed to keep the subbase from migrating into the silts. Excavation of the silts and placement of the first lift of subbase should occur relatively concurrently. Wet weather will add moisture to the silt subgrade resulting in lose of strength, pumping of the silts, and possible migration of the subbase into the silts.

8.0 CLOSURE AND LIMITATIONS

The analysis, conclusions, and recommendations contained in this report are based on site conditions as they presently exist and further assume that the exploratory borings

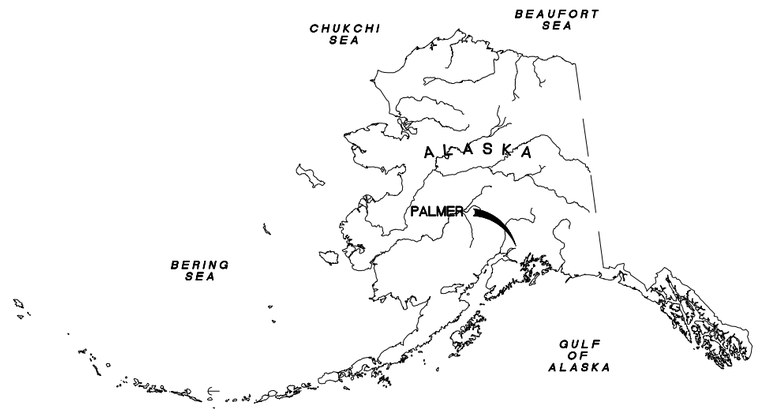
are representative of the subsurface conditions throughout the site, that is, that the subsurface conditions everywhere are not significantly different from those disclosed by the exploration. If during construction, subsurface conditions different from those encountered in the exploratory borings are observed or appear to be present beneath excavations, advise us at once so we can review these conditions and reconsider our recommendations when necessary.

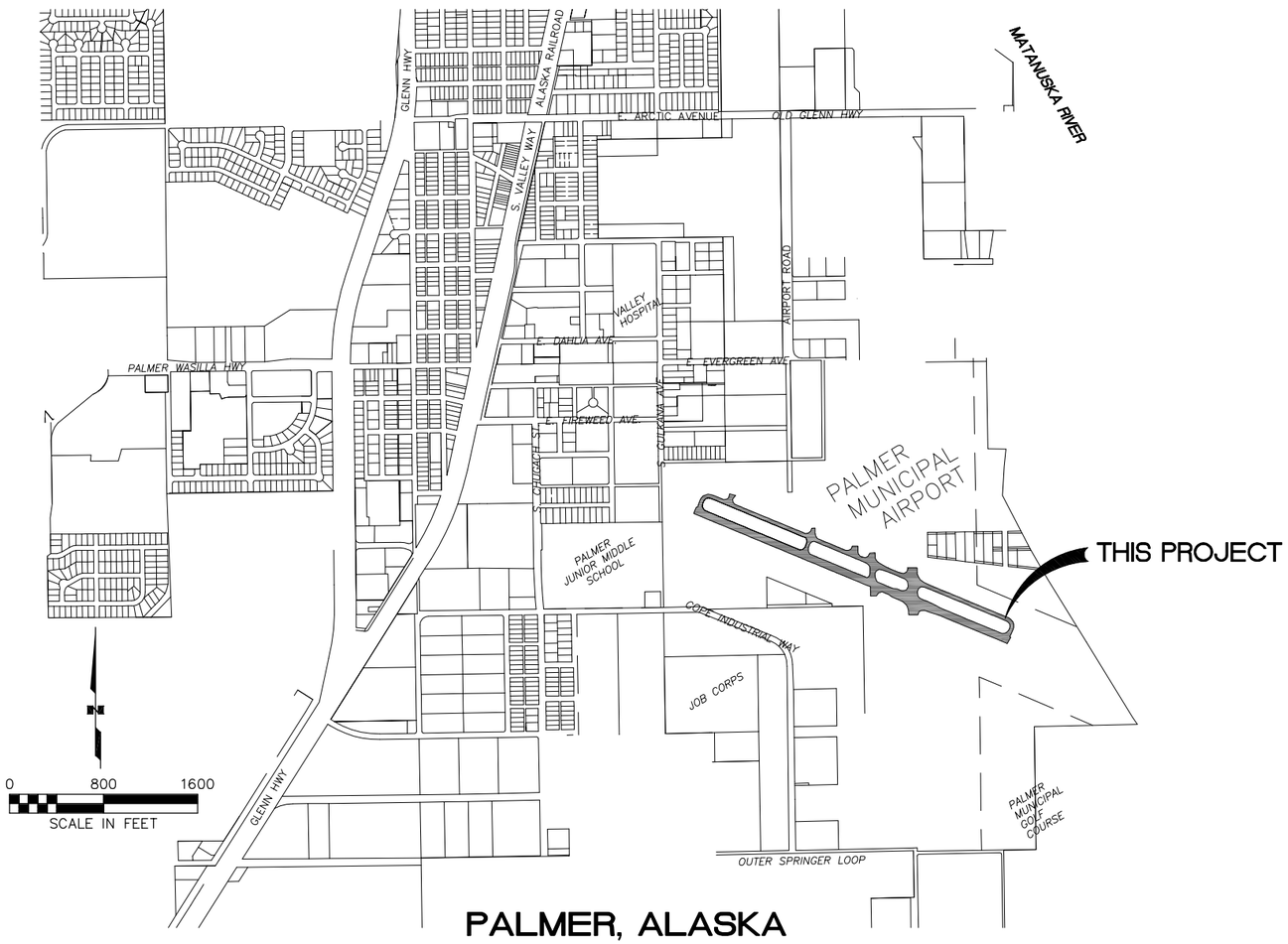
If substantial time has elapsed between submission of this report and the start of work at the site, or if conditions have changed because of natural causes or construction operations at or adjacent to the site, we recommend that this report be reviewed to determine the applicability of the conclusions and recommendations considering the time lapse or changed conditions.

Unanticipated soil conditions are commonly encountered and cannot be fully determined by merely taking soil samples or borings. Such unexpected conditions frequently require additional expenditure to attain a properly constructed project. Therefore, some contingency fund is recommended to accommodate such potential extra costs.

Prepared by:
Hattenburg Dilley & Linnell, LLC

Lorie M. Dilley, P.E., C.P.G.
Principal Geotechnical Engineer





PALMER, ALASKA

PALMER MUNICIPAL AIRPORT
GEOTECHNICAL REPORT
CONSTRUCT RUNWAY 9/27
AND RELATED IMPROVEMENTS

AIP NO. 03-02-0211-0701
AIP NO. 03-02-0211-0802

PALMER, ALASKA

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RUNWAY 9-27 REHABILITATION
PALMER MUNICIPAL AIRPORT
PALMER, ALASKA

SHEET TITLE
RUNWAY 9/27
VICINITY MAP

SHEET
FIGURE 1

DRAWN BY: | CHECKED BY:
DATE: 11/30/05 | SCALE: AS NOTED
JOB NUMBER: 05-021

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VIEW: F01_F_D0800, F01_H_L5000, F01_H_X7700
XREF: 05021_00_BD01, 05021_00_X01

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LAYOUT: Layout1

XREF: 05021_00_BD01

RUNWAY 9/27 BOREHOLE LOCATION MAP

RUNWAY 9-27 REHABILITATION

PALMER MUNICIPAL AIRPORT

PALMER, ALASKA

SHEET: FIGURE 2

SHEET TITLE: RUNWAY 9/27 BOREHOLE LOCATION MAP

DATE: 11/30/05

JOB NUMBER: 05-021

SCALE: AS NOTED

DRAWN BY:

CHECKED BY:

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REVISIONS		
MARK	DATE	DESCRIPTION
1		
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TAXIWAY B

RUNWAY 9/27

MATCHLINE – STA 10+00

BH-7

LEGEND

" = THICKNESS OF EXISTING STRUCTURAL SECTION

0 30 60
SCALE IN FEET

BH-7

2" ASPHALT CONCRETE PAVEMENT
Medium dense, gray, slightly silty, sandy GRAVEL (GP-GM) dry. F1

Sandy GRAVEL

20"

Soft to firm, brown/gray, sandy SILT, moist

SILT

Medium dense to very dense, brown, slightly silty, sandy GRAVEL w/cobbles, moist

Sandy GRAVEL

REVISIONS		
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RUNWAY 9-27 REHABILITATION

PALMER MUNICIPAL AIRPORT

PALMER, ALASKA

SHEET TITLE
RUNWAY 9/27
PLAN & PROFILE
STA 1+50 TO
STA 10+00

SHEET
FIGURE 3

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JOB NUMBER: 05-021

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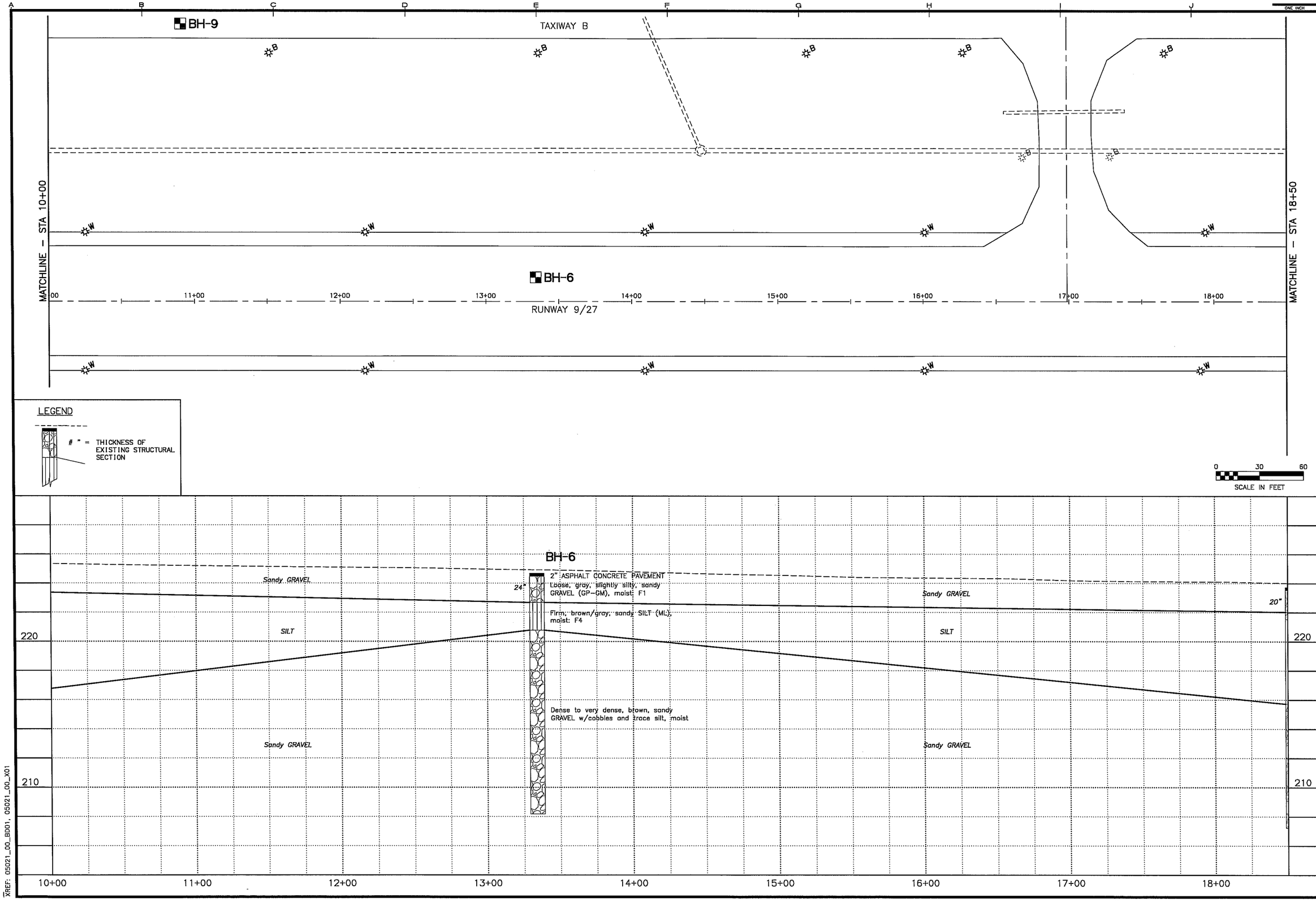
LAYOUT: FIG3
XREF: 05021_00_BD01, 05021_00_X01



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PLAN & PROFILE
STA 10+00 TO
STA 18+50

SHEET: FIGURE 4

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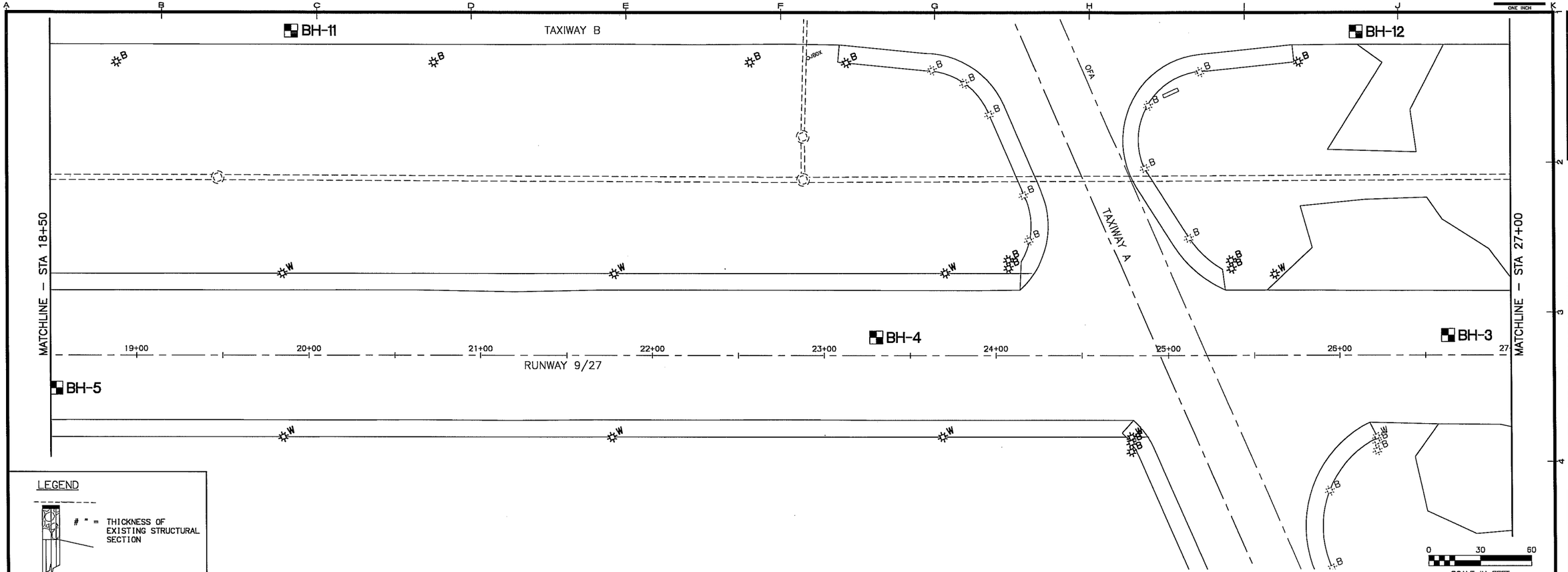
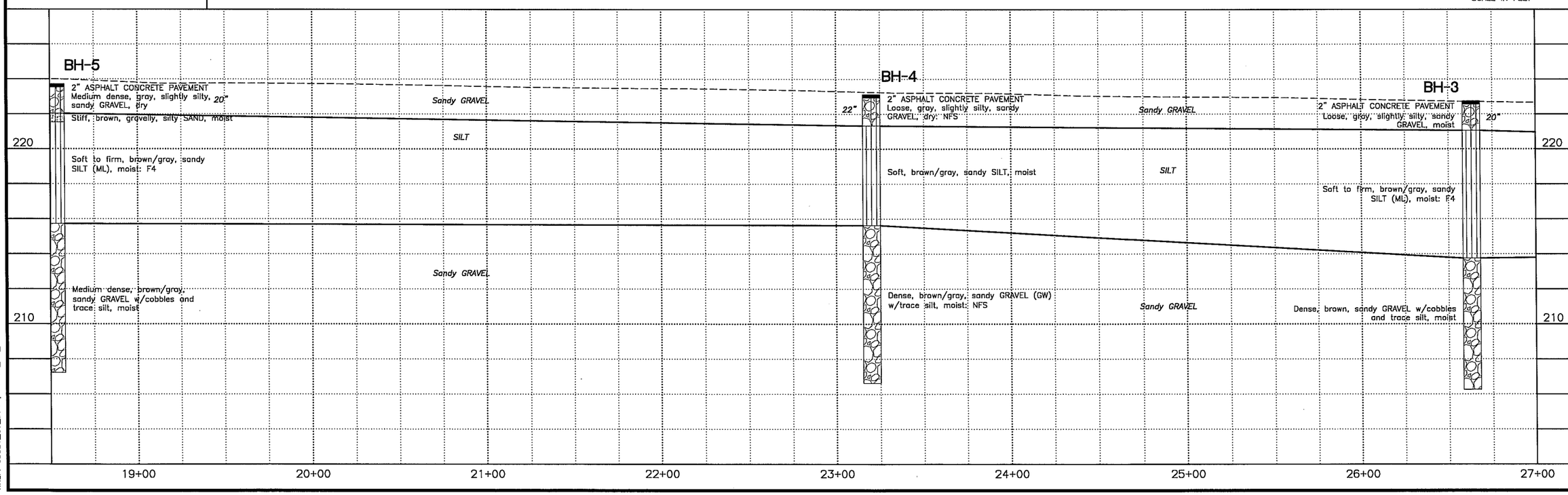
DATE: 11/30/05	SCALE: AS NOTED

JOB NUMBER: 05-021



LEGEND

" = THICKNESS OF EXISTING STRUCTURAL SECTION



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PALMER, ALASKA

SHEET TITLE
RUNWAY 9/27
PLAN & PROFILE
STA 18+50 TO
STA 27+00

SHEET
FIGURE 5

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LAYOUT: FIG5
XREF: 05021_00_BD01, 05021_00_X01

TAXIWAY B

BH-13

MATCHLINE – STA 27+00

MATCHLINE – STA 35+50

CONDUIT JBOX

CONDUIT JBOX

VASI JBOX

OLT-RW

RUNWAY 16/34

OFA

28+00 29+00 30+00 31+00 32+00 33+00 34+00 35+00

RUNWAY 9/27

BH-2

LEGEND

" = THICKNESS OF EXISTING STRUCTURAL SECTION

0 30 60

SCALE IN FEET

BH-2

26"

2" ASPHALT CONCRETE PAVEMENT

Medium dense, brown, slightly silty, sandy GRAVEL (GW-GM) moist; F1

Medium dense, gray, gravelly SAND w/trace silt, moist

Medium dense, sandy GRAVEL w/trace silt, moist

Stiff, brown, sandy SILT, moist

Dense, brown, sandy GRAVEL w/cobbles and trace silt, moist

Very dense, brown, silty, sandy GRAVEL w/cobbles; moist

Sandy GRAVEL

SILT

Sandy GRAVEL

220

210

27+00 28+00 29+00 30+00 31+00 32+00 33+00 34+00 35+00

REVISIONS		
MARK	DATE	DESCRIPTION
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PALMER, ALASKA

SHEET TITLE
RUNWAY 9/27
PLAN & PROFILE
STA 27+00 TO
STA 35+50

SHEET
FIGURE 6

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DATE: 11/30/05	SCALE: AS NOTED

JOB NUMBER: 05-021

TAXIWAY B

6' HIGH CHAIN LINK FENCE

MATCHLINE – STA 35+50

BH-1

36+00 37+00 38+00 39+00 40+00 41+00 42+00 43+00 44+00

RUNWAY 9/27

LEGEND

" = THICKNESS OF EXISTING STRUCTURAL SECTION

0 30 60
SCALE IN FEET

BH-1

2" ASPHALT CONCRETE PAVEMENT
Loose, gray, slightly silty, sandy GRAVEL (GP–GM) dry; F1

20"

Sandy GRAVEL

SILT

Soft, brown/gray, sandy SILT (ML), moist; F4

Sandy GRAVEL

Medium dense, brown, sandy GRAVEL w/trace silt, moist

220
210
200

36+00 37+00 38+00 39+00 40+00 41+00 42+00 43+00 44+00

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MARK	DATE	DESCRIPTION
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PALMER, ALASKA

SHEET TITLE
RUNWAY 9/27
PLAN & PROFILE
STA 35+50 TO
STA 44+00

SHEET
FIGURE 7

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JOB NUMBER: 05–021	

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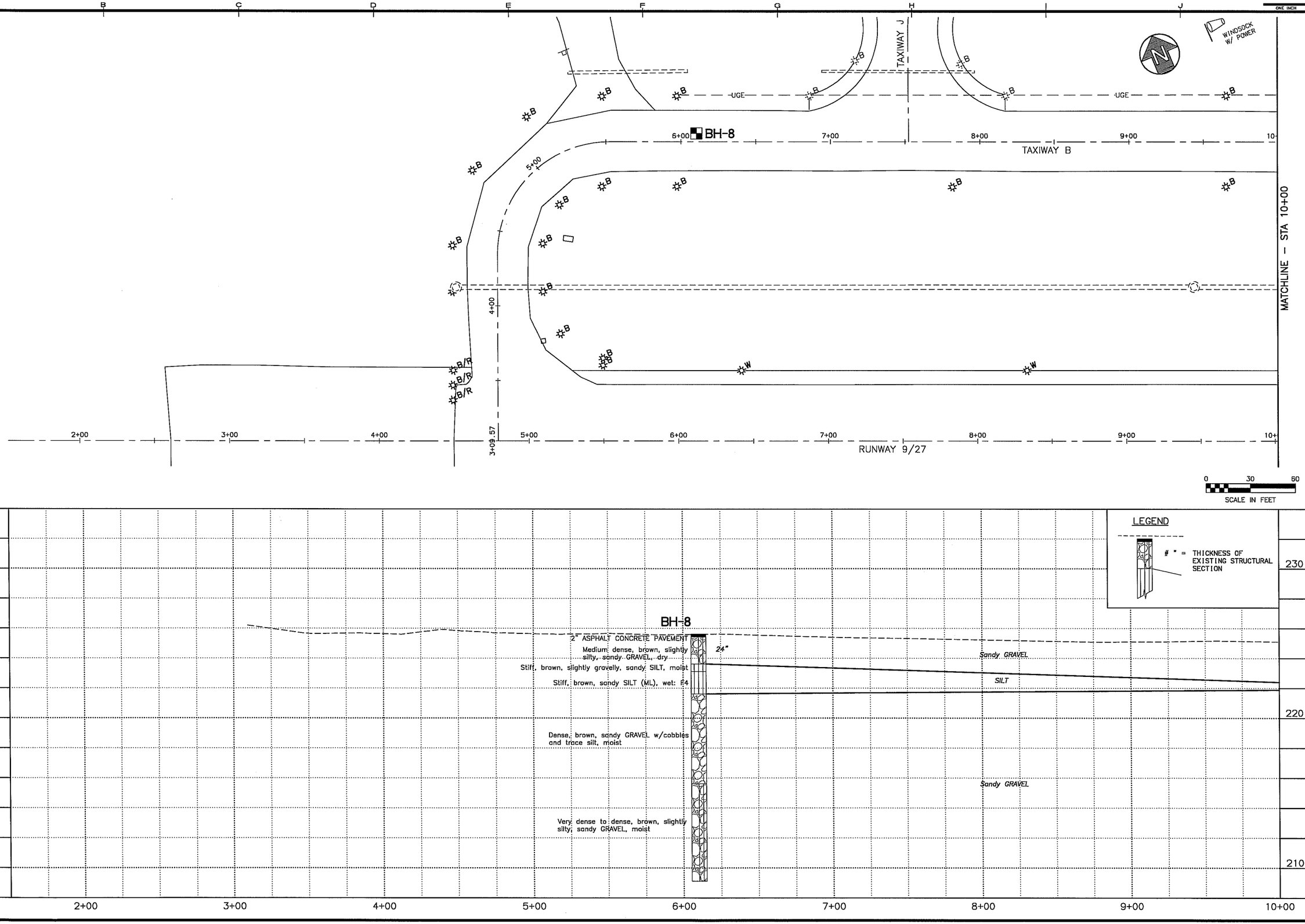
XREF: 05021_00_BD01, 05021_00_X01



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PALMER MUNICIPAL AIRPORT

PALMER, ALASKA

SHEET TITLE
TAXIWAY B
PLAN & PROFILE
STA 3+09.57 TO
STA 10+00

SHEET
FIGURE 8

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DATE: 11/30/05	SCALE: AS NOTED

JOB NUMBER: 05-021

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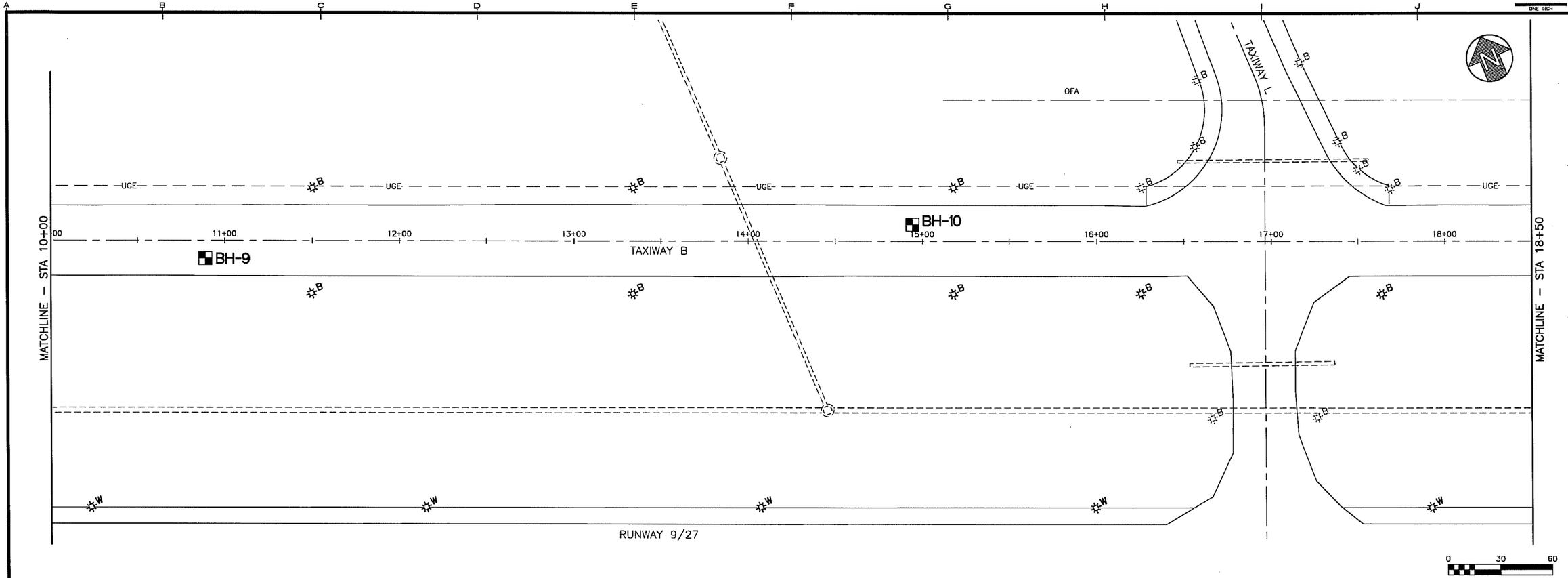
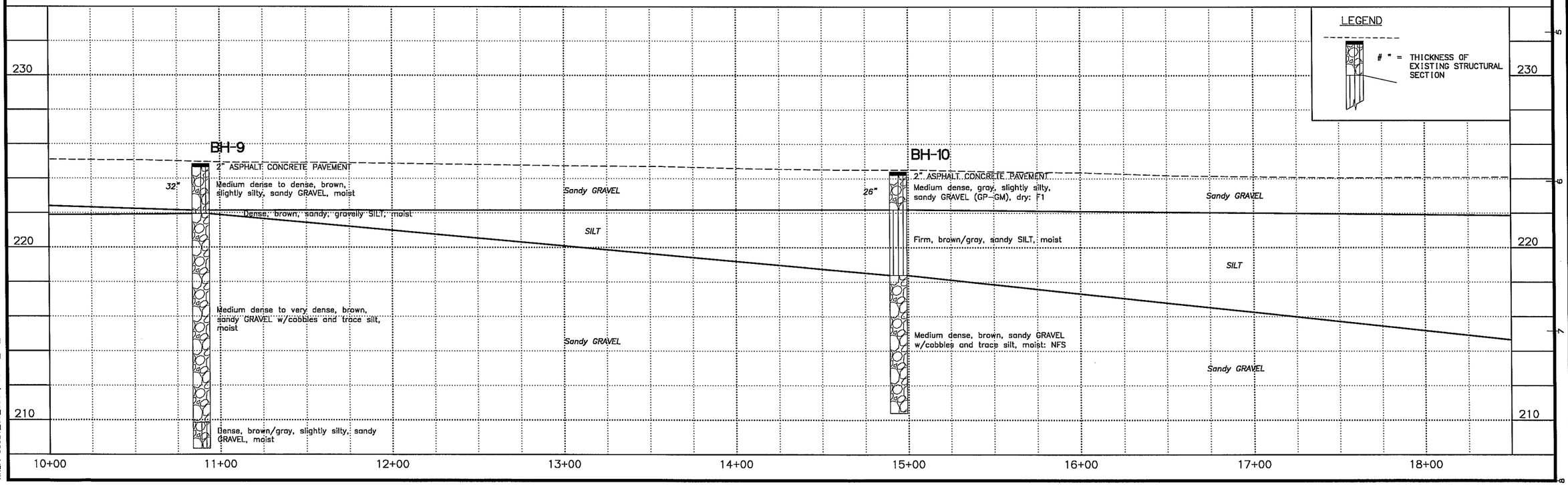
XREF: 05021_00_B001, 05021_00_X01





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RUNWAY 9–27 REHABILITATION

PALMER MUNICIPAL AIRPORT

PALMER, ALASKA

SHEET TITLE
TAXIWAY B
PLAN & PROFILE
STA 10+00 TO
STA 18+50

SHEET
FIGURE 9

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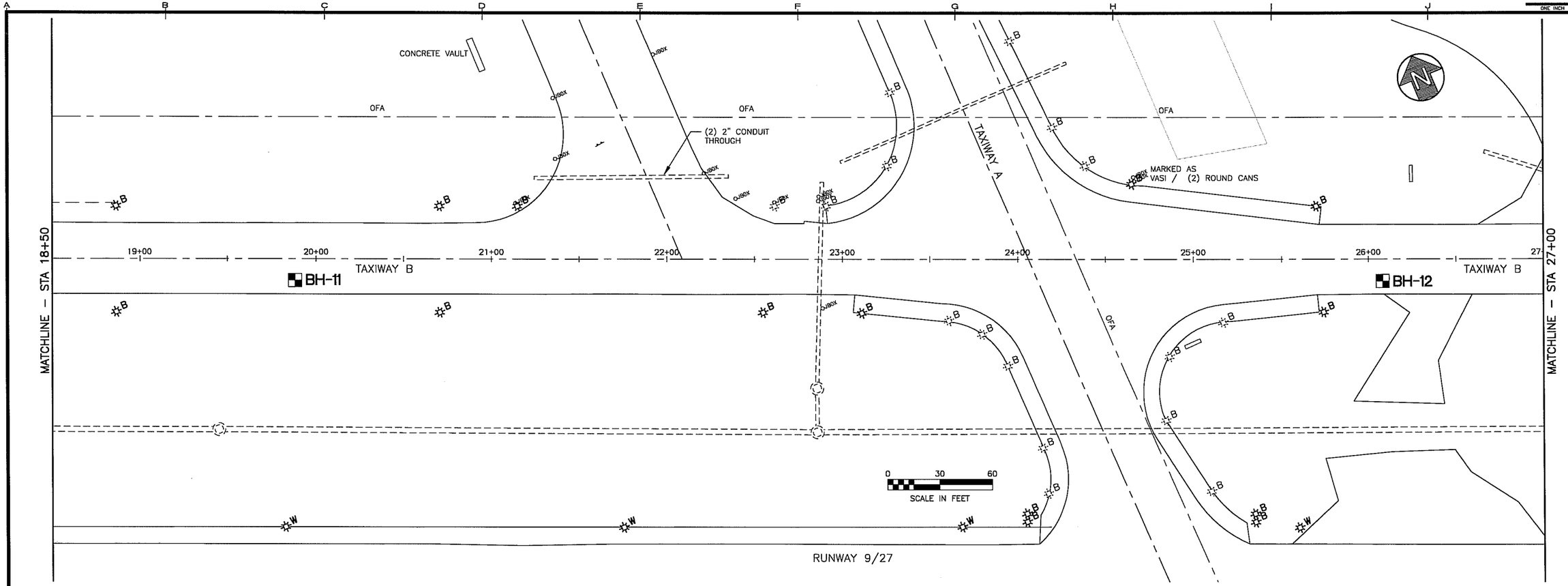
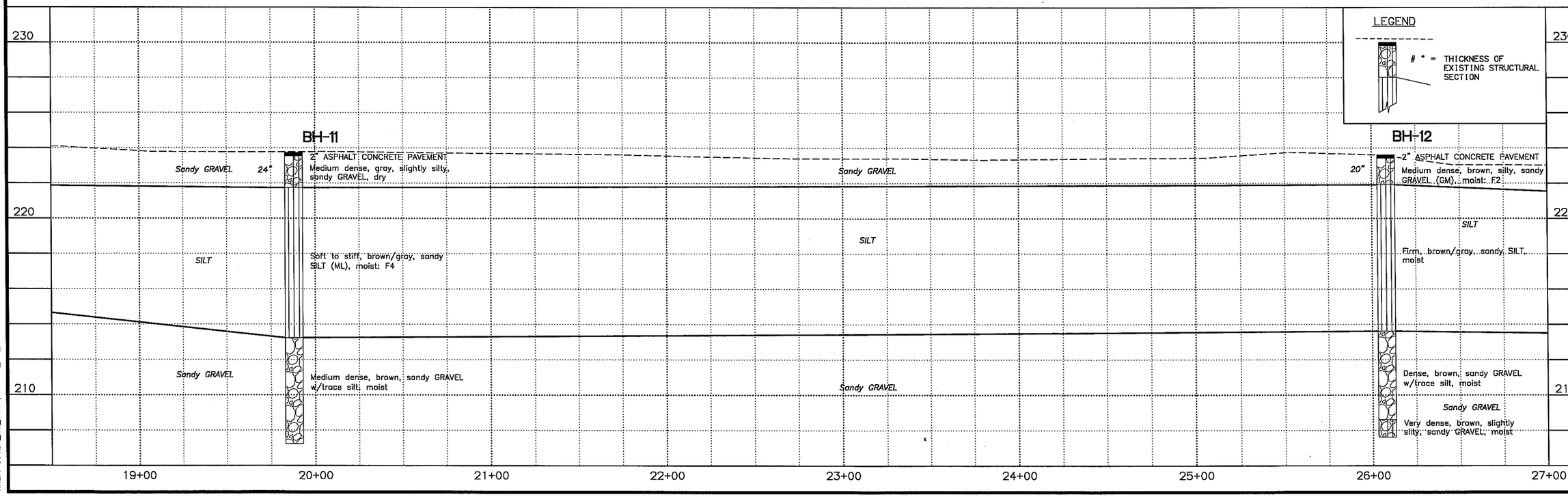
XREF: 05021_00_BD01, 05021_00_X01





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PALMER MUNICIPAL AIRPORT

PALMER, ALASKA

SHEET TITLE
TAXIWAY B
PLAN & PROFILE
STA 18+50 TO
STA 27+00

SHEET
FIGURE 10

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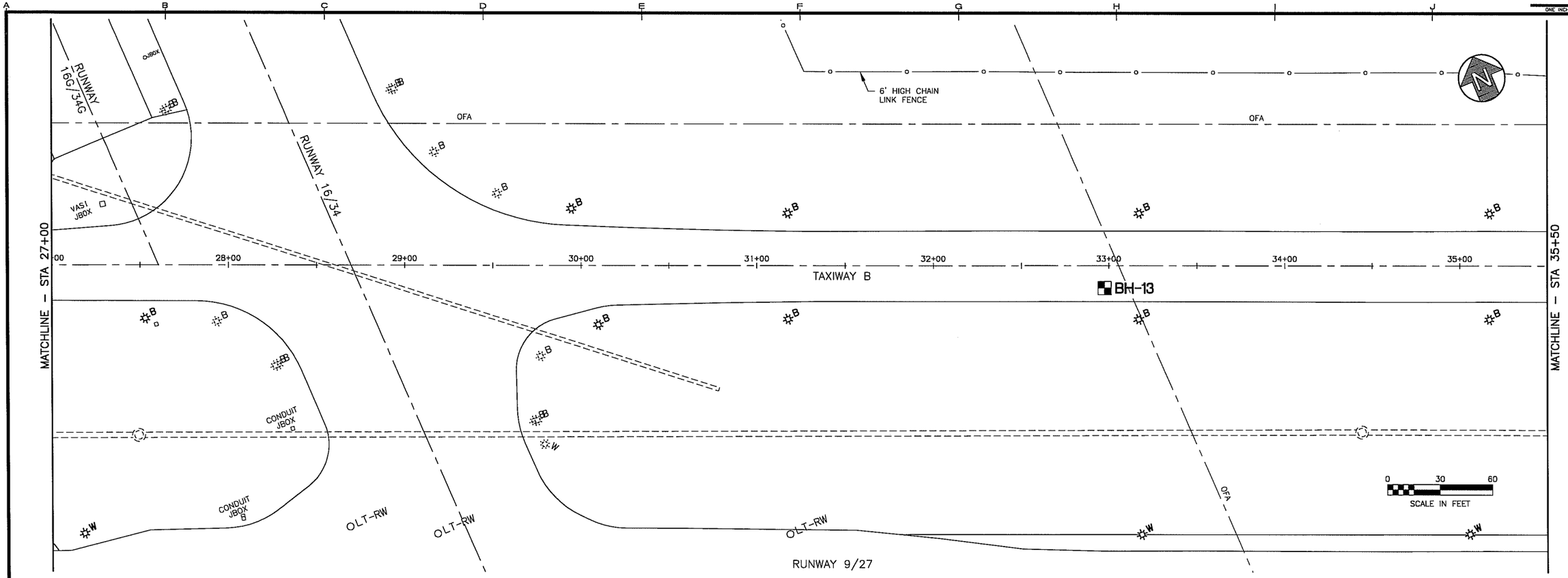

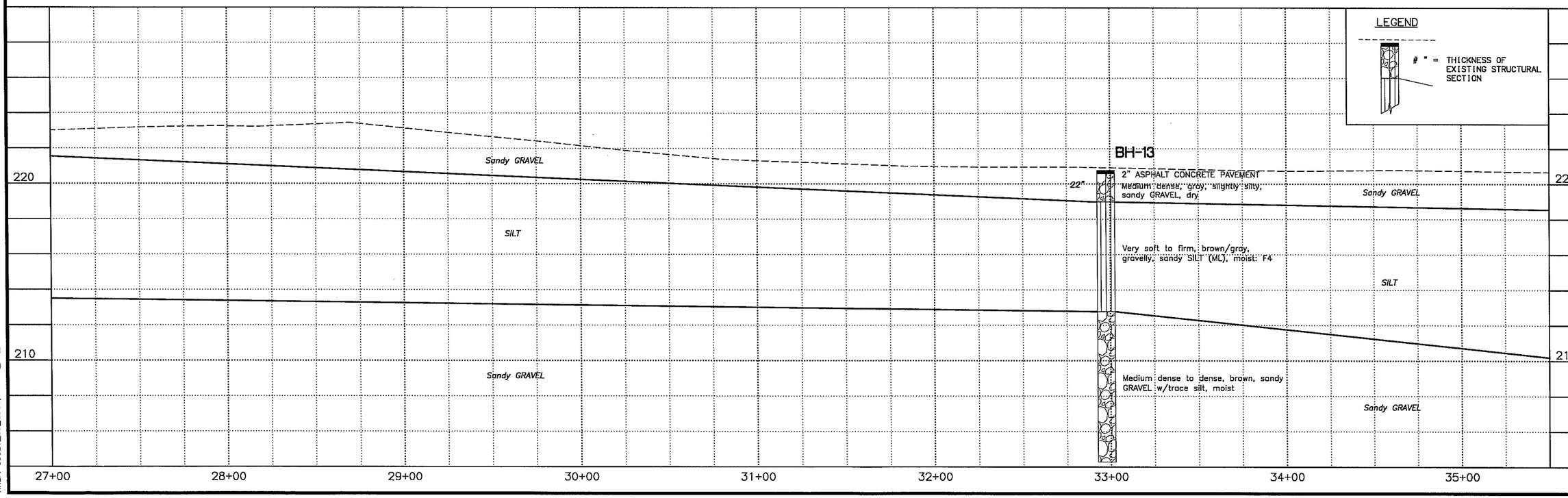

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PALMER MUNICIPAL AIRPORT

PALMER, ALASKA

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SHEET: FIGURE 11

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OFA

MATCHLINE — STA 35+50

BH-14

36+00 37+00 38+00 39+00 40+00 41+00 42+00 43+00 44+00

TAXIWAY B

BH-1

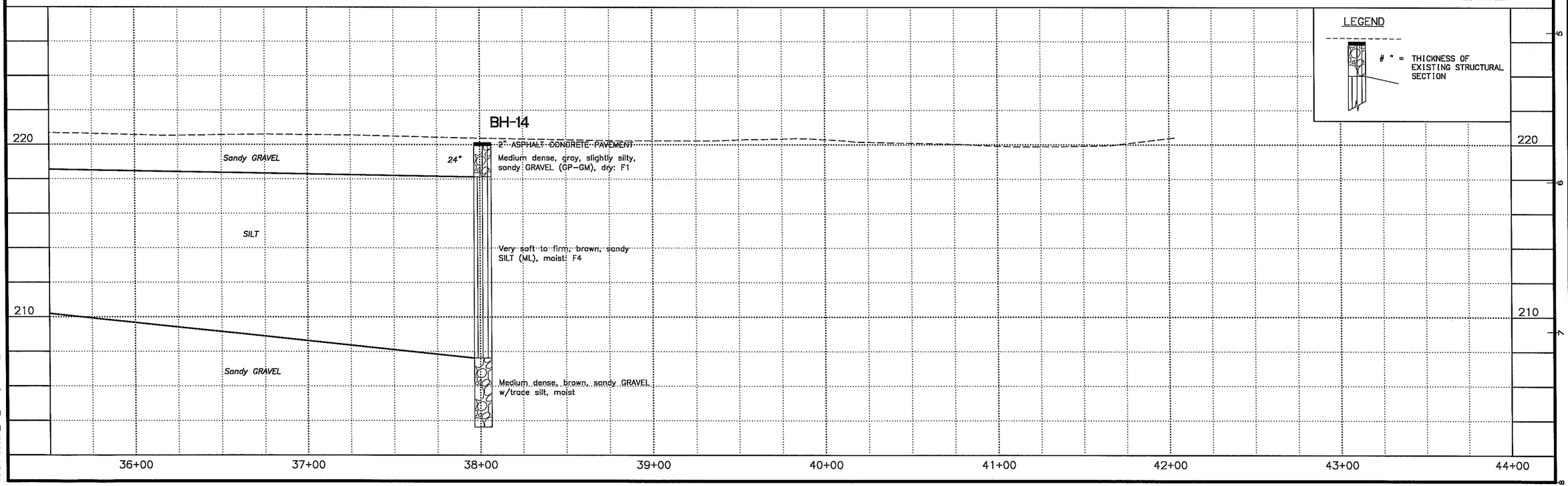
RUNWAY 9/27

6' HIGH CHAIN LINK FENCE

0 30 60
SCALE IN FEET

LEGEND

" = THICKNESS OF EXISTING STRUCTURAL SECTION



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SHEET TITLE
TAXIWAY B
PLAN & PROFILE
STA 35+50 TO
STA 42+03.08

SHEET
FIGURE 12

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DATE:	SCALED:
11/30/05	AS NOTED

JOB NUMBER:
05-021

LEVELING COURSE

SIEVE SIZE	PERCENT PASSING BY WEIGHT
1"	100
3/4"	70-100
3/8"	50-80
NO. 4	35-65
NO. 8	20-50
NO. 50	10-30
NO. 20O	3-8 *

* THE FRACTION OF MATERIAL PASSING THE NO. 200 SIEVE SHALL NOT BE GREATER THAN 75% OF THE FRACTION PASSING THE NO. 50 SIEVE

TYPE II-A BASE

SIEVE SIZE	PERCENT PASSING BY WEIGHT
3"	100
3/4"	50-100
NO. 4	25-60
NO. 10	15-50
NO. 40	4-30
NO. 200	2-6 *

* THE FRACTION OF MATERIAL PASSING THE NO. 200 SIEVE SHALL NOT BE GREATER THAN 20% OF THE FRACTION PASSING THE NO. 4 SIEVE

TYPE II SUBBASE

SIEVE SIZE	PERCENT PASSING BY WEIGHT
8"	100
3"	70-100
1-1/2"	55-100
3/4"	45-85
NO. 4	20-60
NO. 10	12-50
NO. 40	4-30
NO. 200	2-6 *

* THE FRACTION OF MATERIAL PASSING THE NO. 200 SIEVE SHALL NOT BE GREATER THAN 20% OF THE FRACTION PASSING THE NO. 4 SIEVE

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GRADATION REQUIREMENTS
PALMER MUNICIPAL AIRPRORT
PALMER, ALASKA

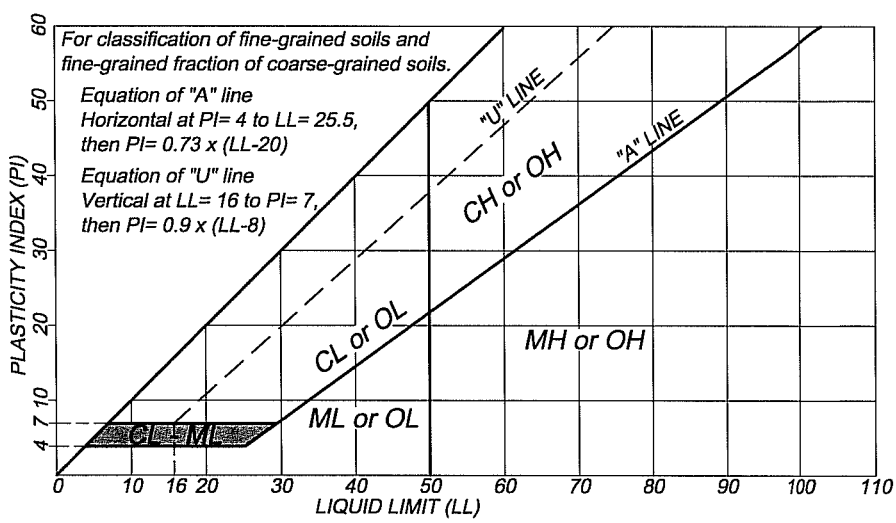
DATE: 11/30/05	DRAWN BY:	SHEET: FIGURE 13
SCALE: NTS	CHECKED BY:	JOB NO.: 05-021

APPENDIX A

Figure A-1	Unified Soil Classification System
Figure A-2	Municipality of Anchorage Frost Classification
Figure A-3 to A-19	Log of Borings
Figure A-20 to A-21	Grain Size Distribution Graphs

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Names			Soil Classification Generalized Group Descriptions	
COARSE-GRAINED SOILS More than 50% retained on No. 200 sieve	GRAVELS 50% or more of coarse fraction retained on No. 4 sieve	CLEAN GRAVELS Less than 5% fines	GW	Well-graded Gravels
			GP	Poorly-graded Gravels
		GRAVELS with fines More than 12% fines	GM	Gravel & Silt Mixtures
			GC	Gravel & Clay Mixtures
	SANDS More than 50% of coarse fraction passes No. 4 sieve	CLEAN SANDS Less than 5% fines	SW	Well-graded Sands
			SP	Poorly Graded Sands
		SANDS with FINES More than 12% fines	SM	Sand & Silt Mixtures
			SC	Sand & Clay Mixtures
FINE-GRAINED SOILS 50% or more passes the No. 200 sieve	SILTS AND CLAYS Liquid limit 50% or less	INORGANIC	ML	Non-plastic & Low Plasticity Silts
			CL	Low-plasticity Clays
		ORGANIC	OL	Non-plastic and Low Plasticity Organic Clays Non-plastic and Low Plasticity Organic Silts
	SILTS AND CLAYS Liquid limit greater than 50%	INORGANIC	CH	High-plasticity Clays
			MH	High-plasticity Silts
		ORGANIC	OH	High plasticity Organic Clays High Plasticity Organic Silts
HIGHLY ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor		PT	Peat



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UNIFIED SOIL CLASSIFICATION
PALMER MUNICIPAL AIRPORT
PALMER, ALASKA

DATE: 11/30/05	DRAWN BY:	SHEET: FIGURE A-1
SCALE: NTS	CHECKED BY:	JOB NO.: 05-021

FROST CLASSIFICATION
(modified after Municipality of Anchorage Standards)

GROUP	SOIL TYPE	P200	TYPICAL SOILS
NFS	Sandy Soils Gravelly Soils	0 to 3 0 to 6	SW, SP GW, GP, GW-GM, GP-GM
F1	Sandy Soils Gravelly Soils	3 to 6 6 to 13	SW, SP, SW-SM, SP-SM GM, GW-GM, GP-GW
F2	Sandy Soils Gravelly Soils	6 to 19 13 to 25	SP-SM, SW-SM, SM GM
F3	Sands, except very fine silty sands Gravelly Soils Clays PI > 12	Over 19 Over 25	SM, SC GM, GC CL, CH
F4	All Silts Very fine silty sands Clays, PI < 12 Varved clays and other fine grained, banded sediments	Over 19	ML, MH SM, SC CL, CL-ML CL and ML CL, ML, and SM; CL, CH, and ML; CL, CH, ML, and SM

P200 = percent passing the number 200 sieve

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FROST CLASSIFICATION
PALMER AIRPORT
PALMER, ALASKA

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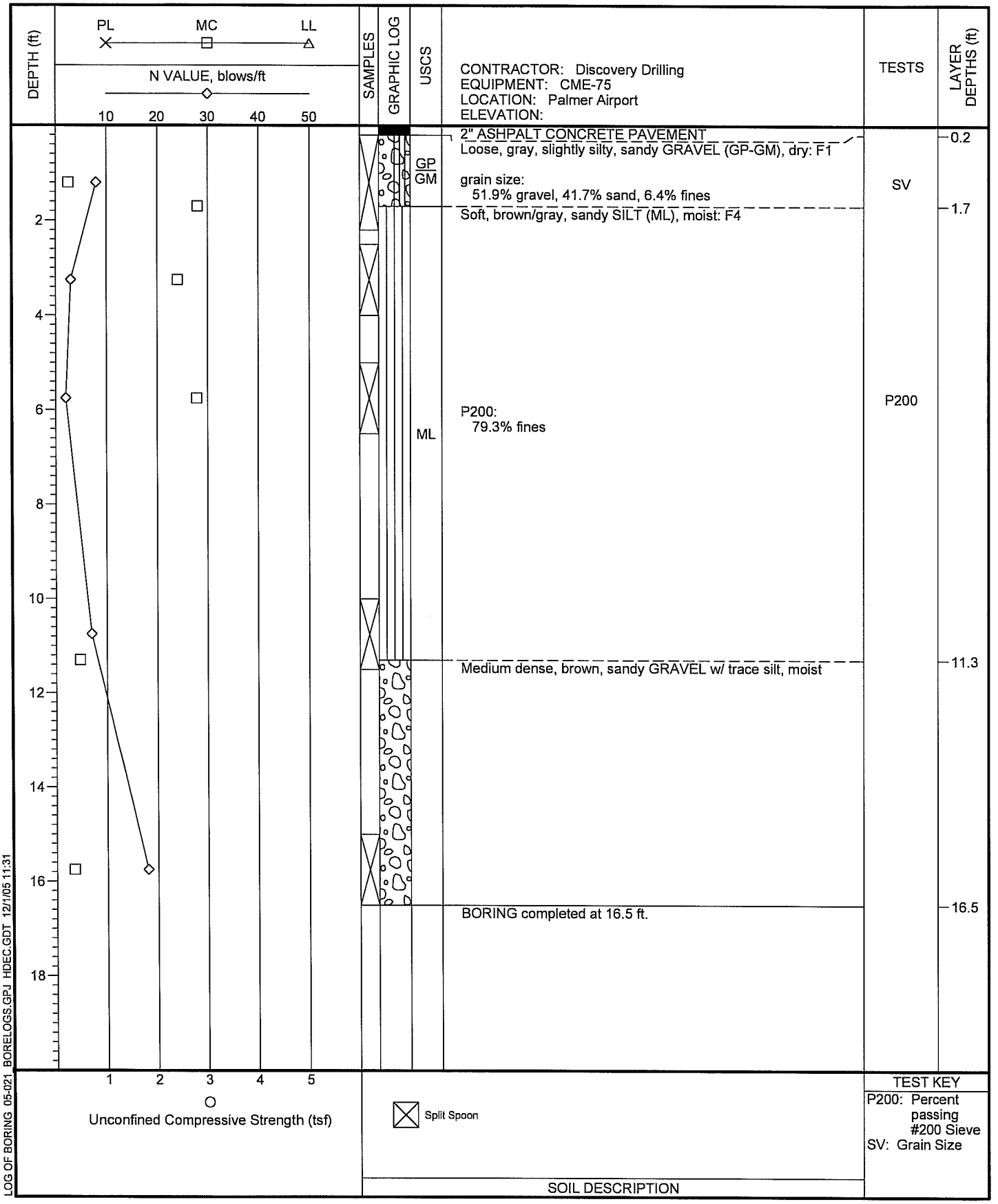
SCALE: NTS	CHECKED BY:	JOB NO.: 05-021



LOG OF BORING 05-021 BORELOGS.GPJ HDEC.GDT 12/1/05 11:31

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Palmer, Alaska

LOG OF BORING BH-01
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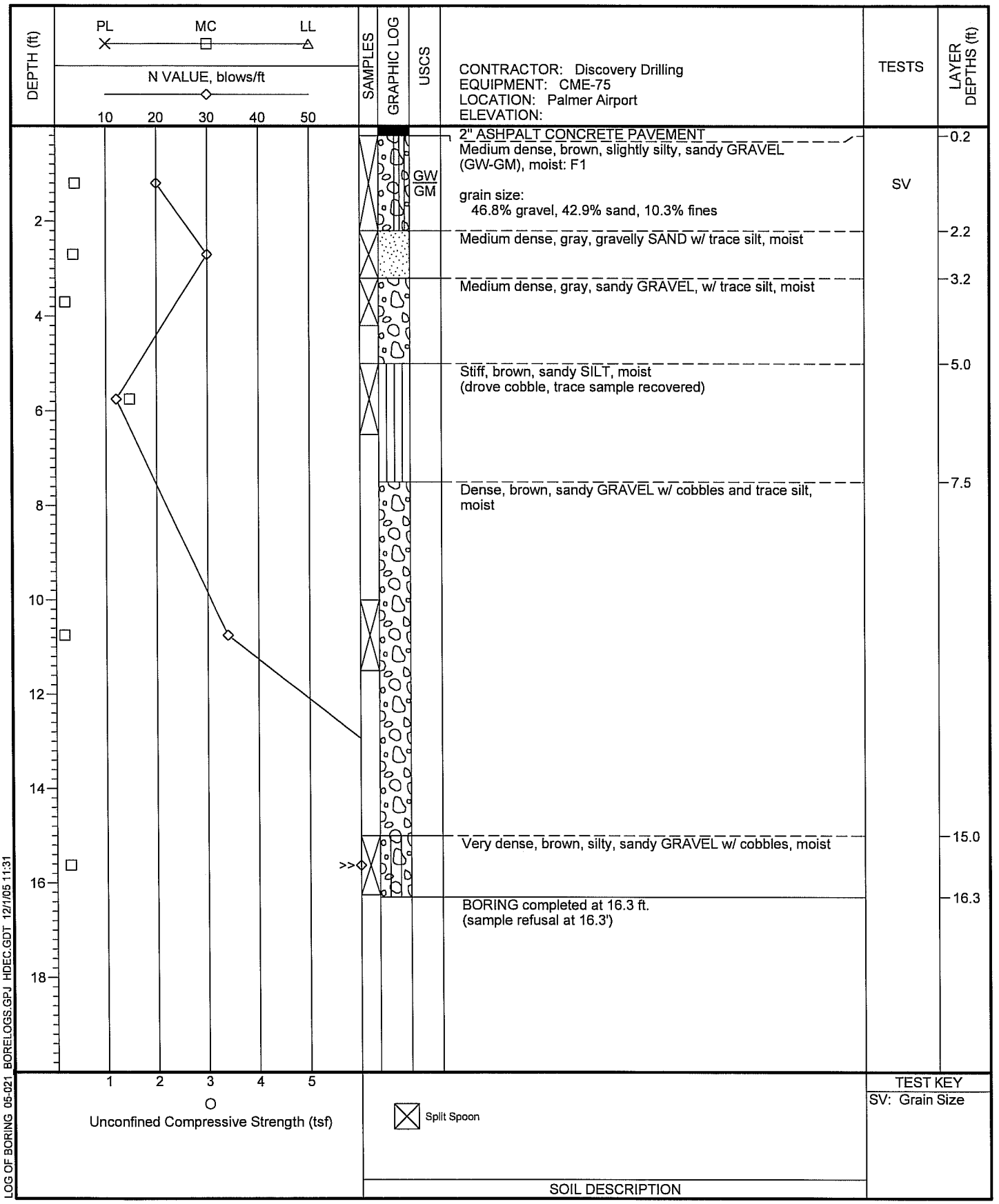
SHEET TITLE: Figure A-3
SHEET: 1 of 1
JOB NUMBER: 05-021



LOG OF BORING 05-021 BORELOGS.GPJ HDEC.GDT 12/1/05 11:31

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City of Palmer
Palmer, Alaska

LOG OF BORING BH-02
LOGGED BY: M. Dale Butikofer
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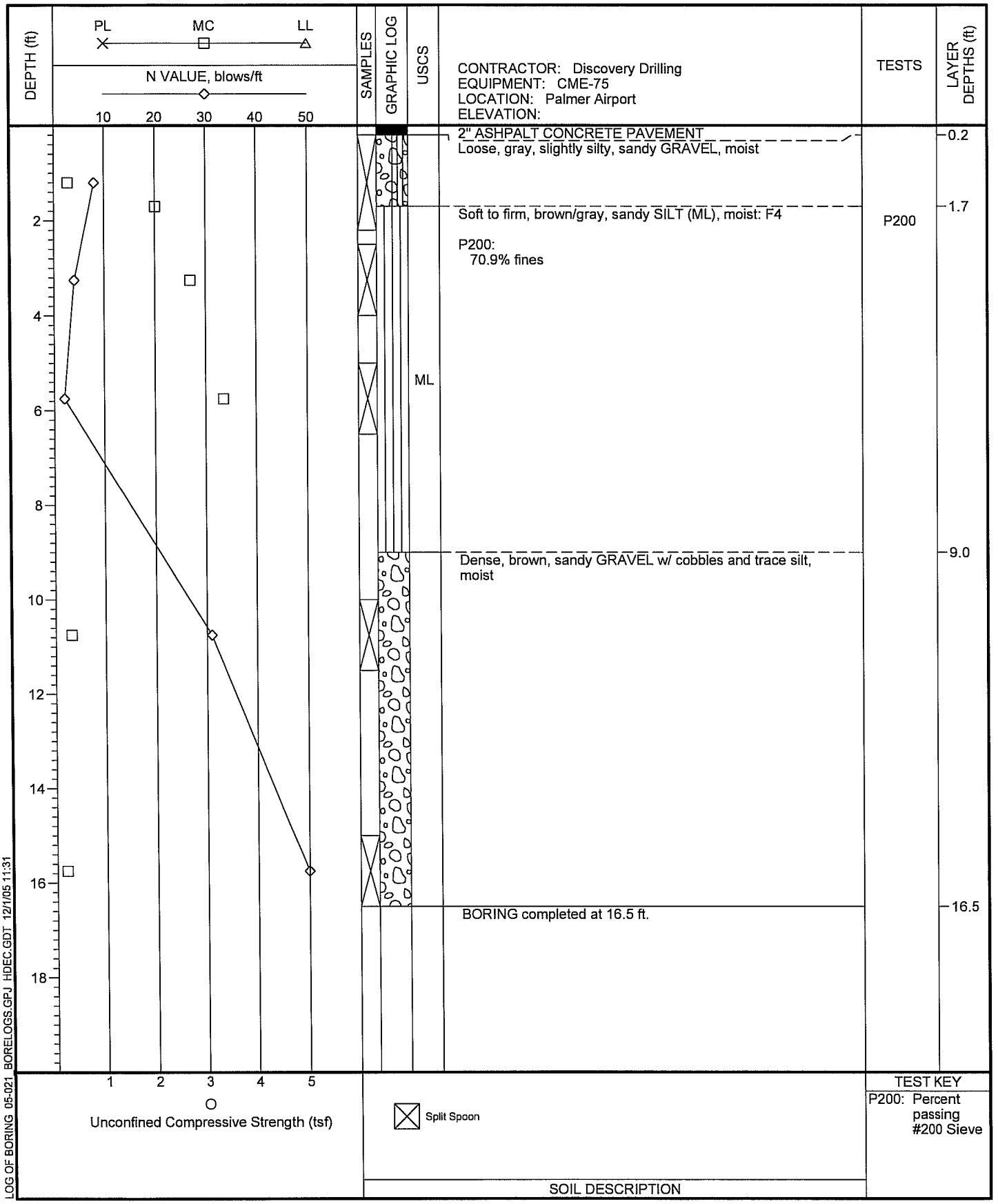
SHEET TITLE: Figure A-4
SHEET: 1 of 1
JOB NUMBER: 05-021



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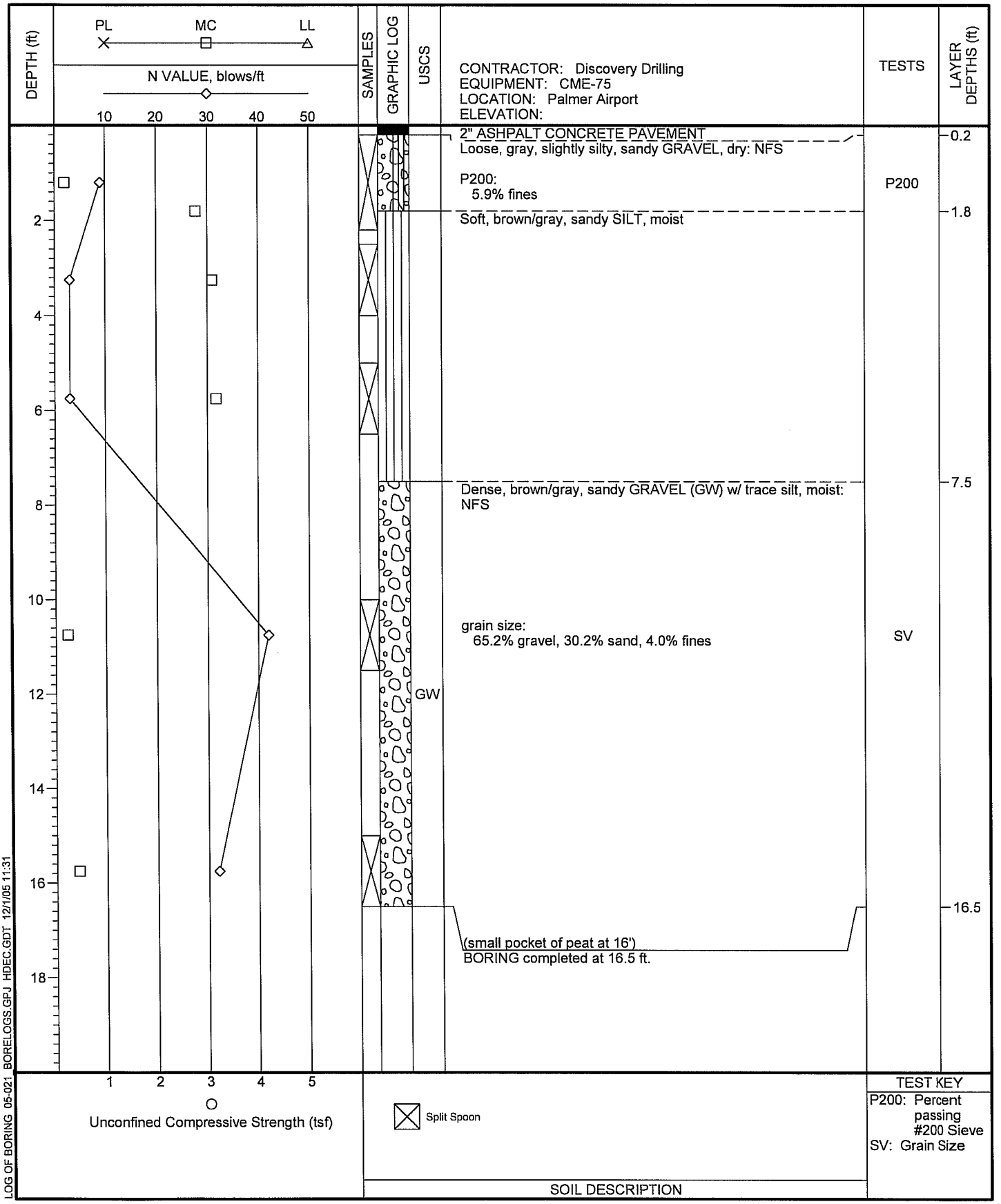
SHEET TITLE: Figure A-5
SHEET: 1 of 1
JOB NUMBER: 05-021



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LOG OF BORING BH-04
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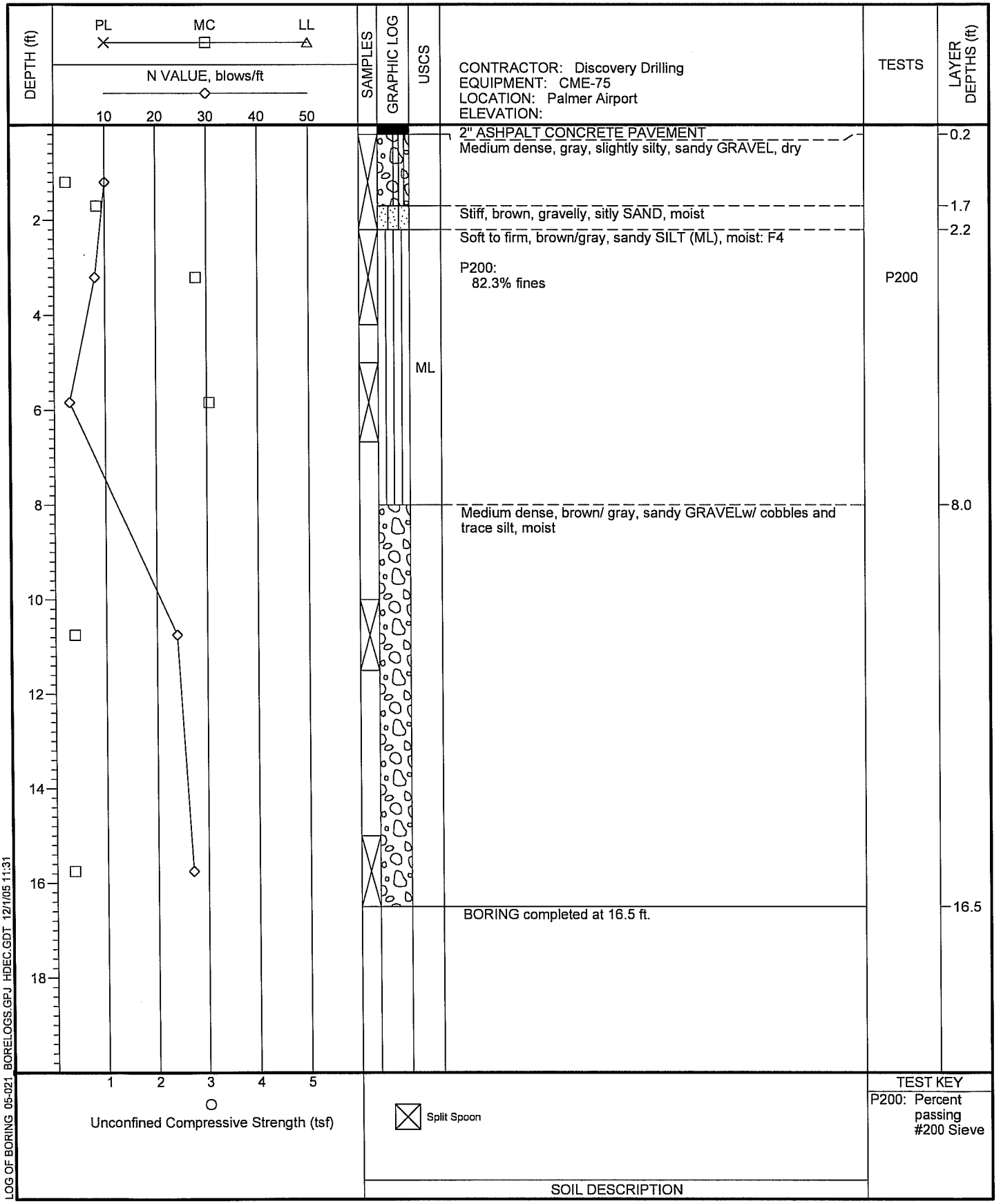
SHEET TITLE: Figure A-6
SHEET: 1 of 1
JOB NUMBER: 05-021



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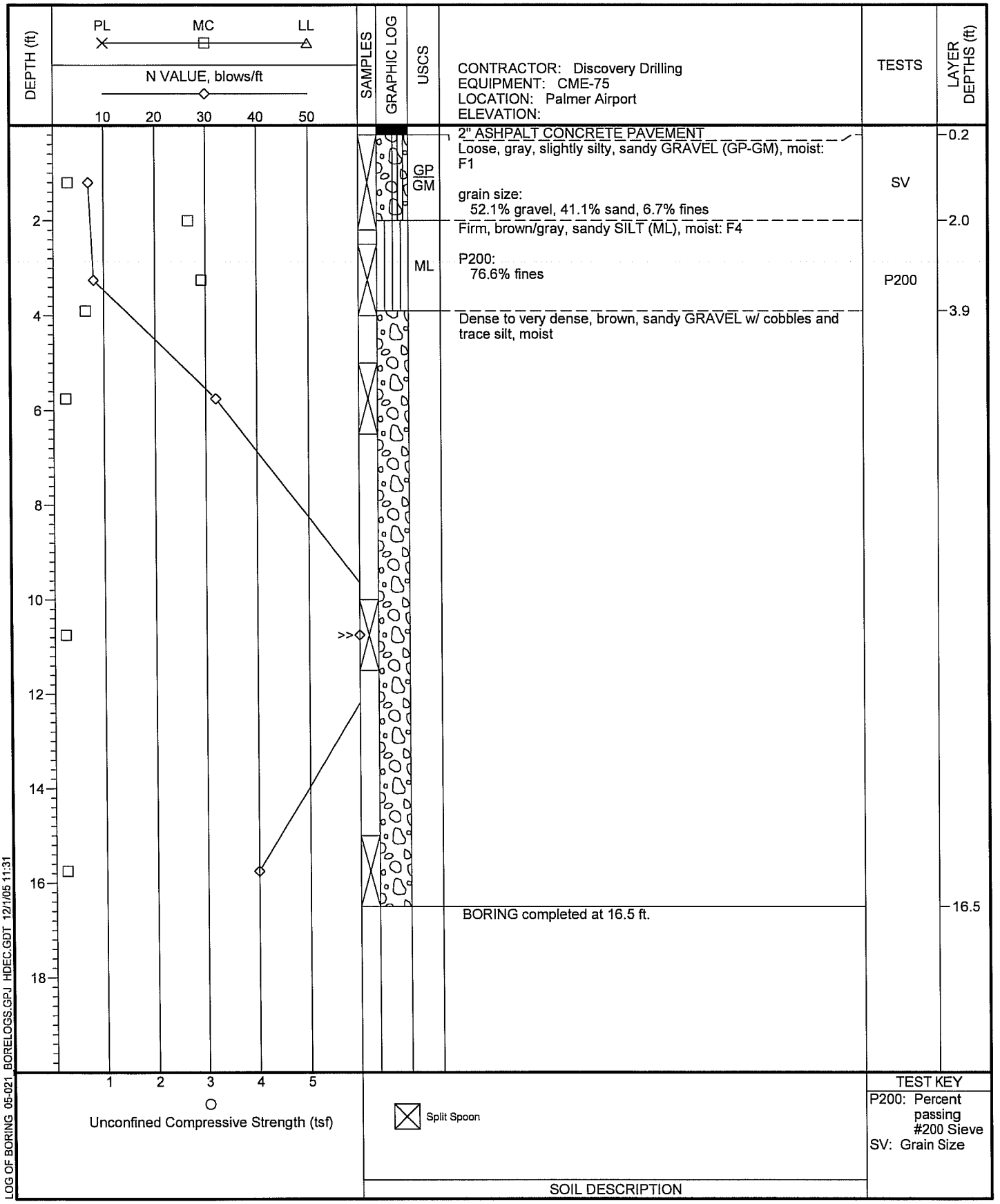
SHEET TITLE: Figure A-7
SHEET: 1 of 1
JOB NUMBER: 05-021



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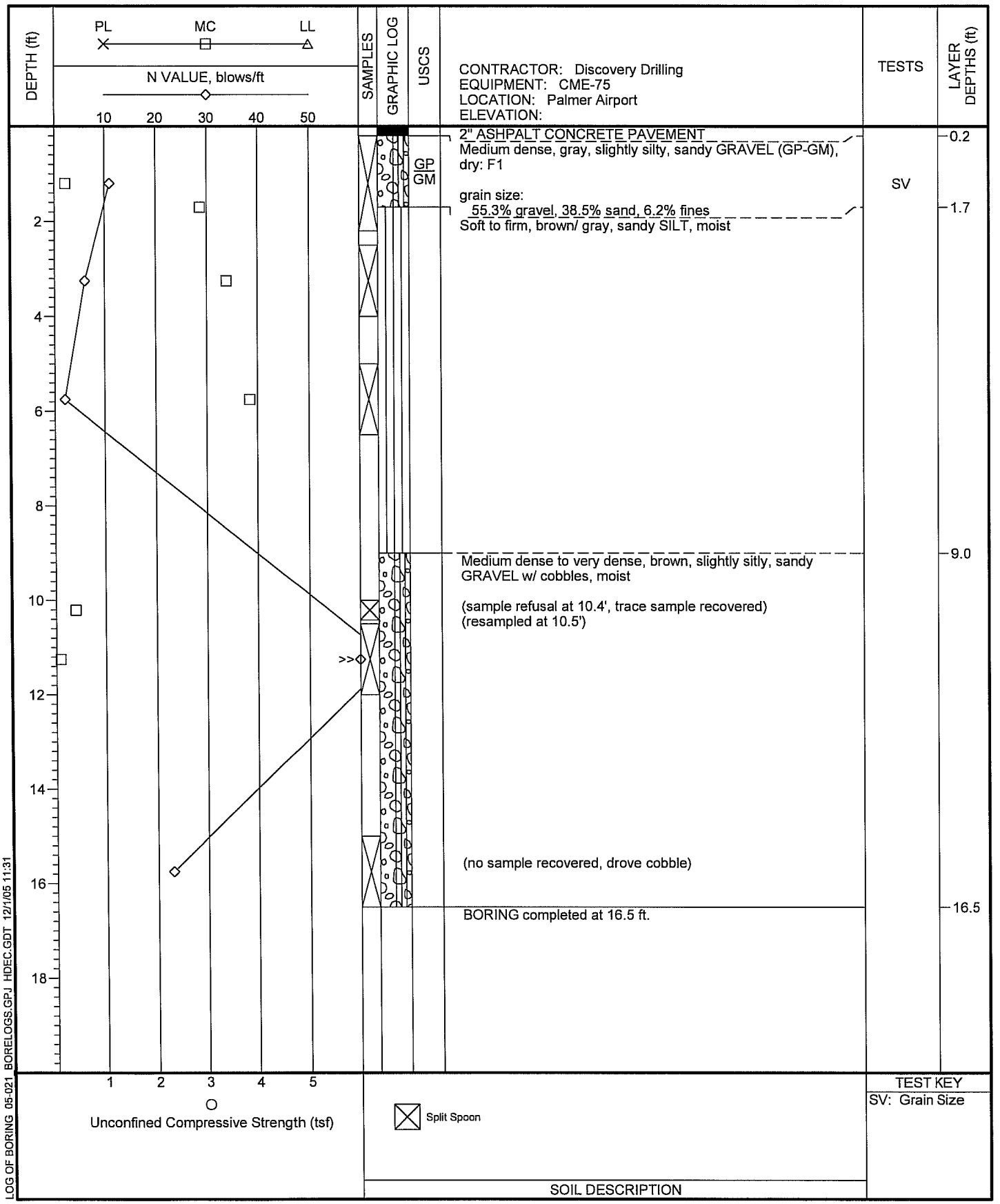
SHEET: 1 of 1
JOB NUMBER: 05-021



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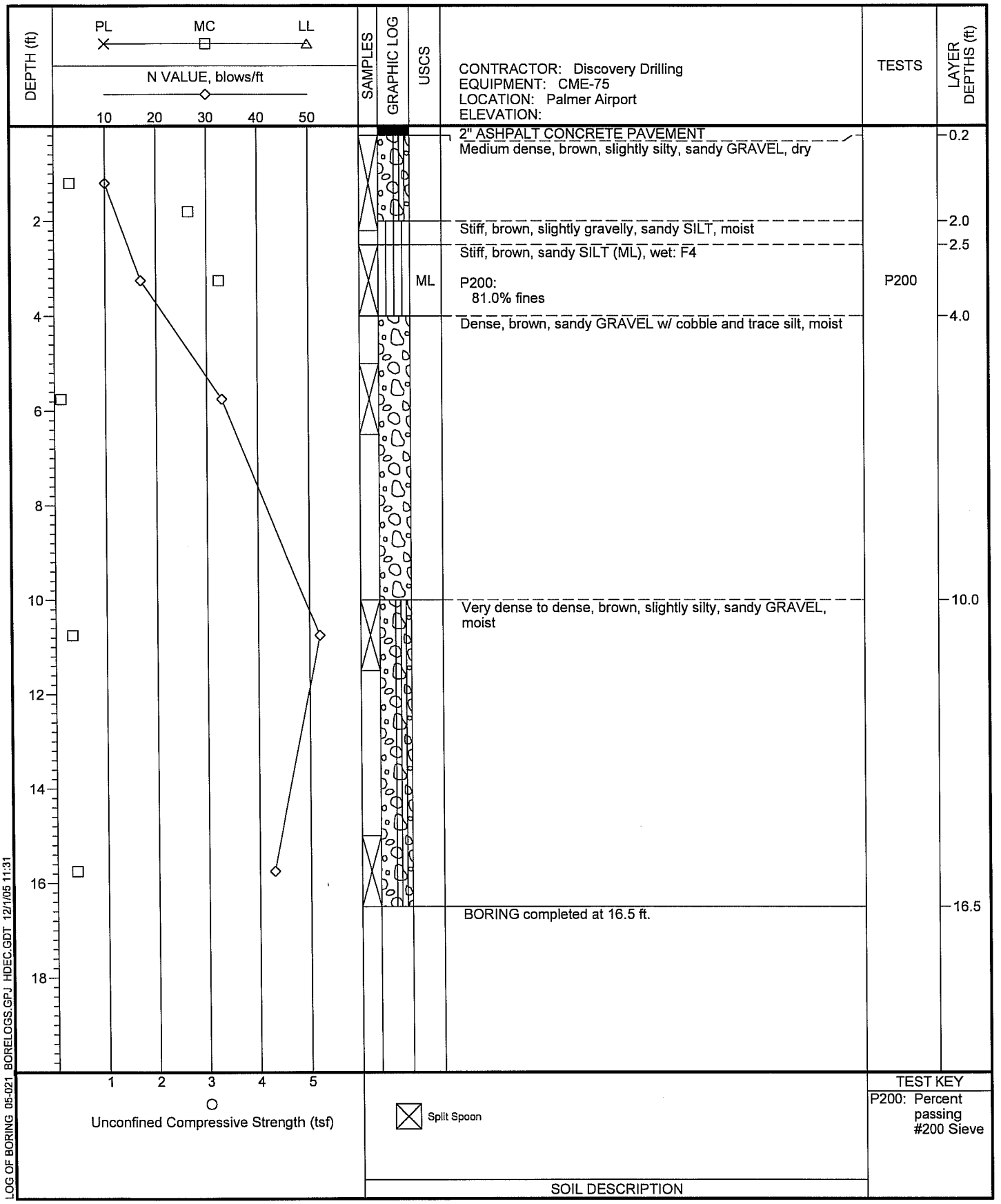

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SHEET: 1 of 1
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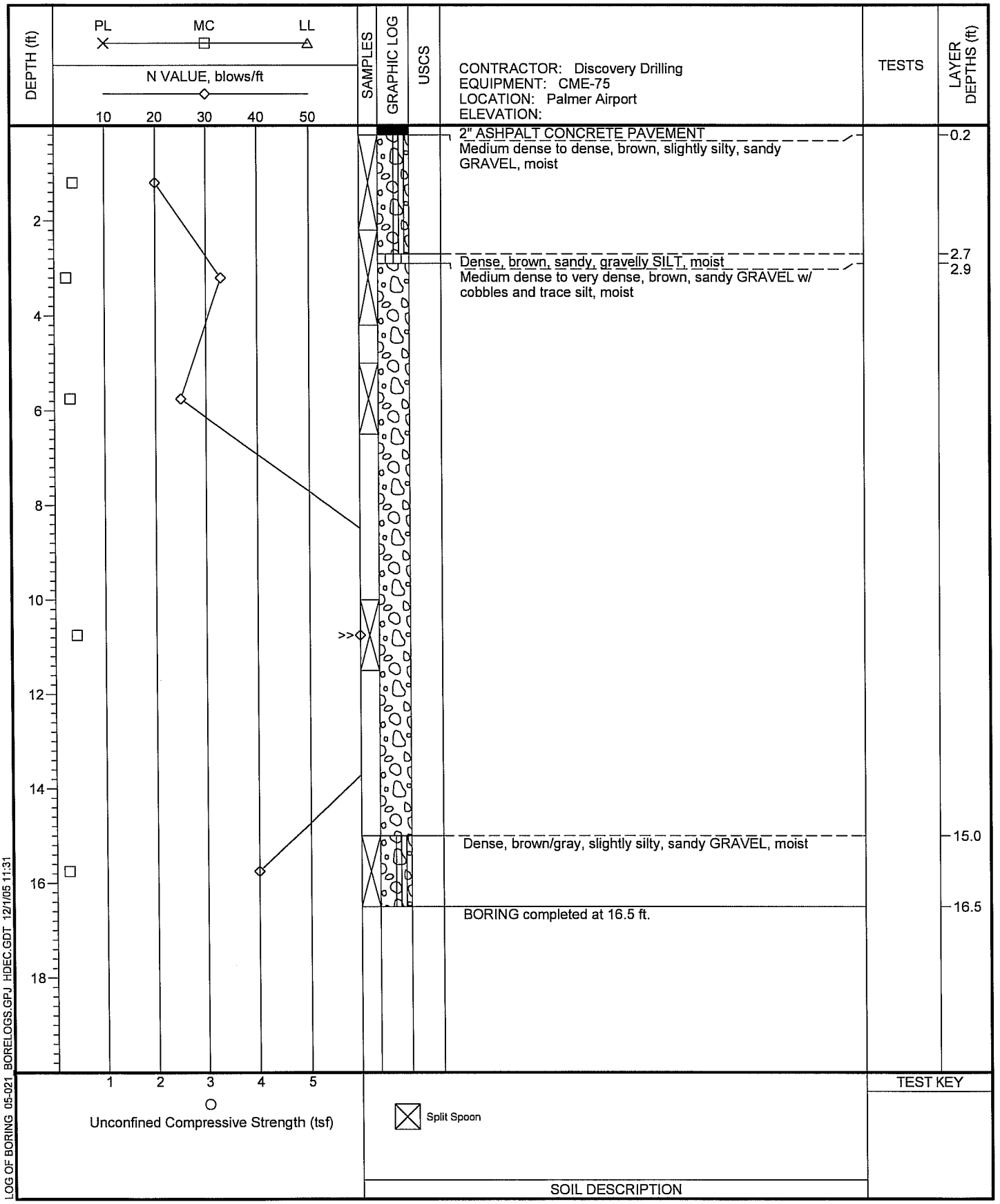

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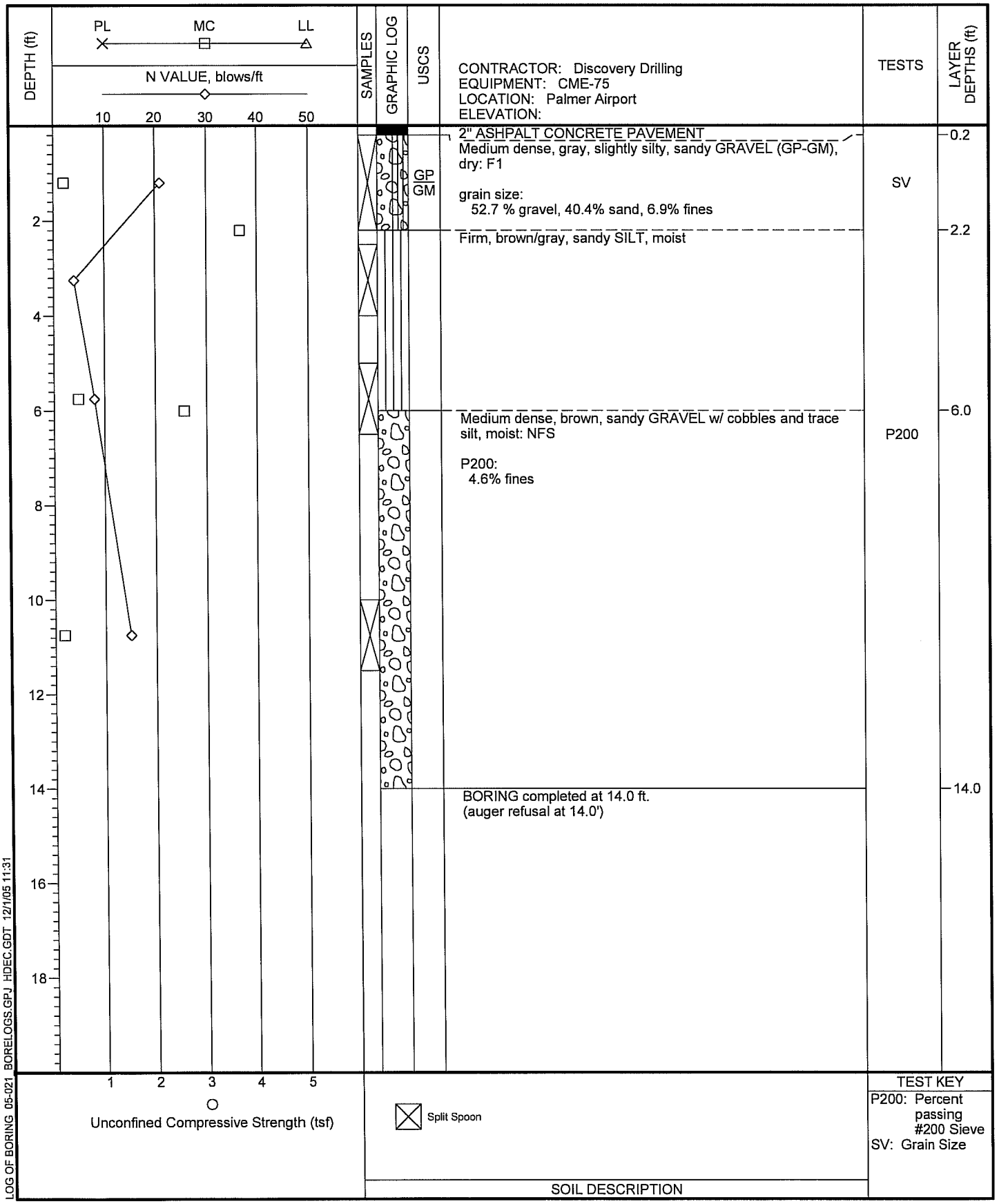
SHEET: 1 of 1
JOB NUMBER: 05-021



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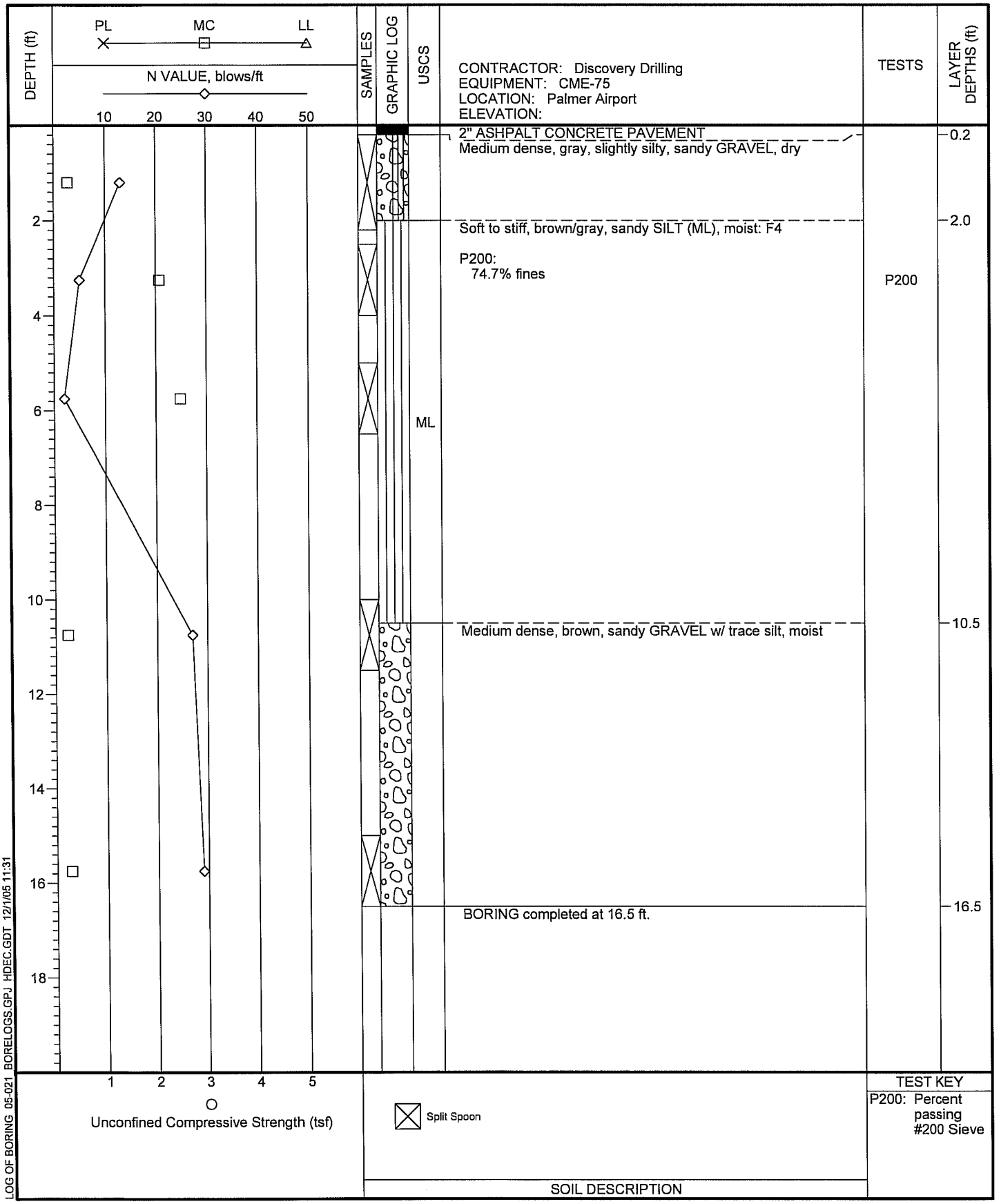
SHEET: 1 of 1
JOB NUMBER: 05-021



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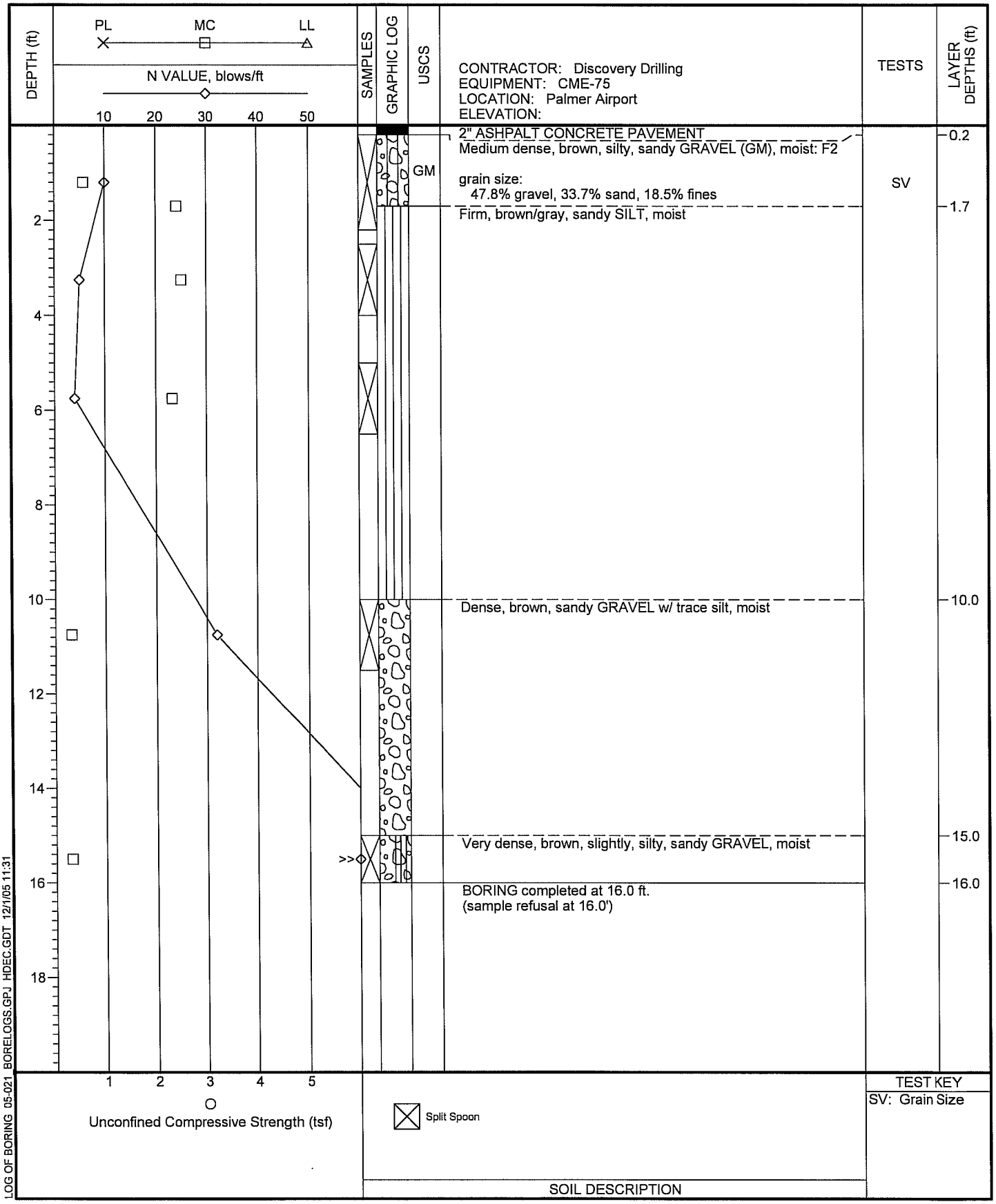
SHEET TITLE: Figure A-13
SHEET: 1 of 1
JOB NUMBER: 05-021



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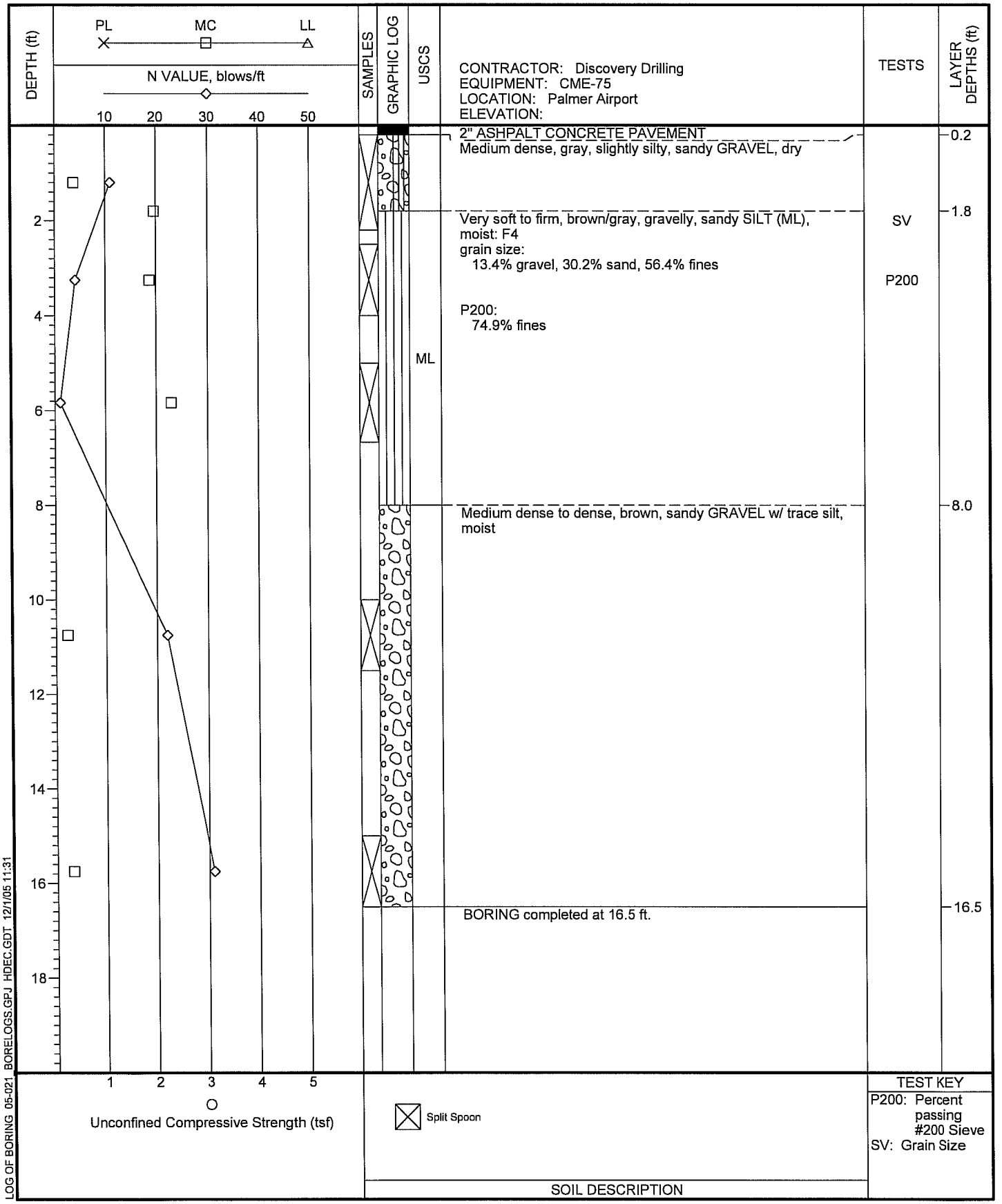
DATE DRILLED: September 21, 2005

SHEET TITLE: Figure A-14
SHEET: 1 of 1
JOB NUMBER: 05-021



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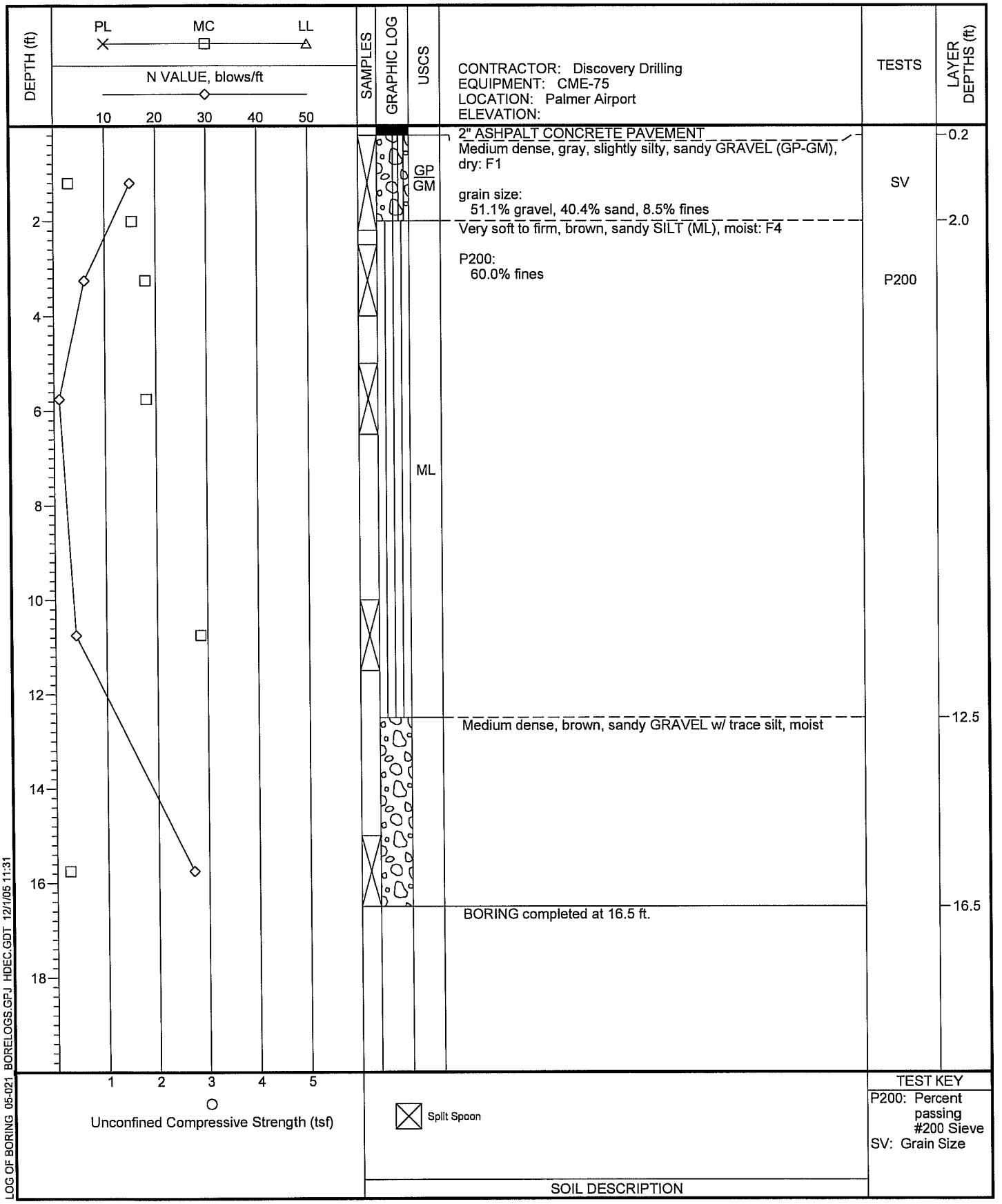
SHEET TITLE: Figure A-15
SHEET: 1 of 1
JOB NUMBER: 05-021



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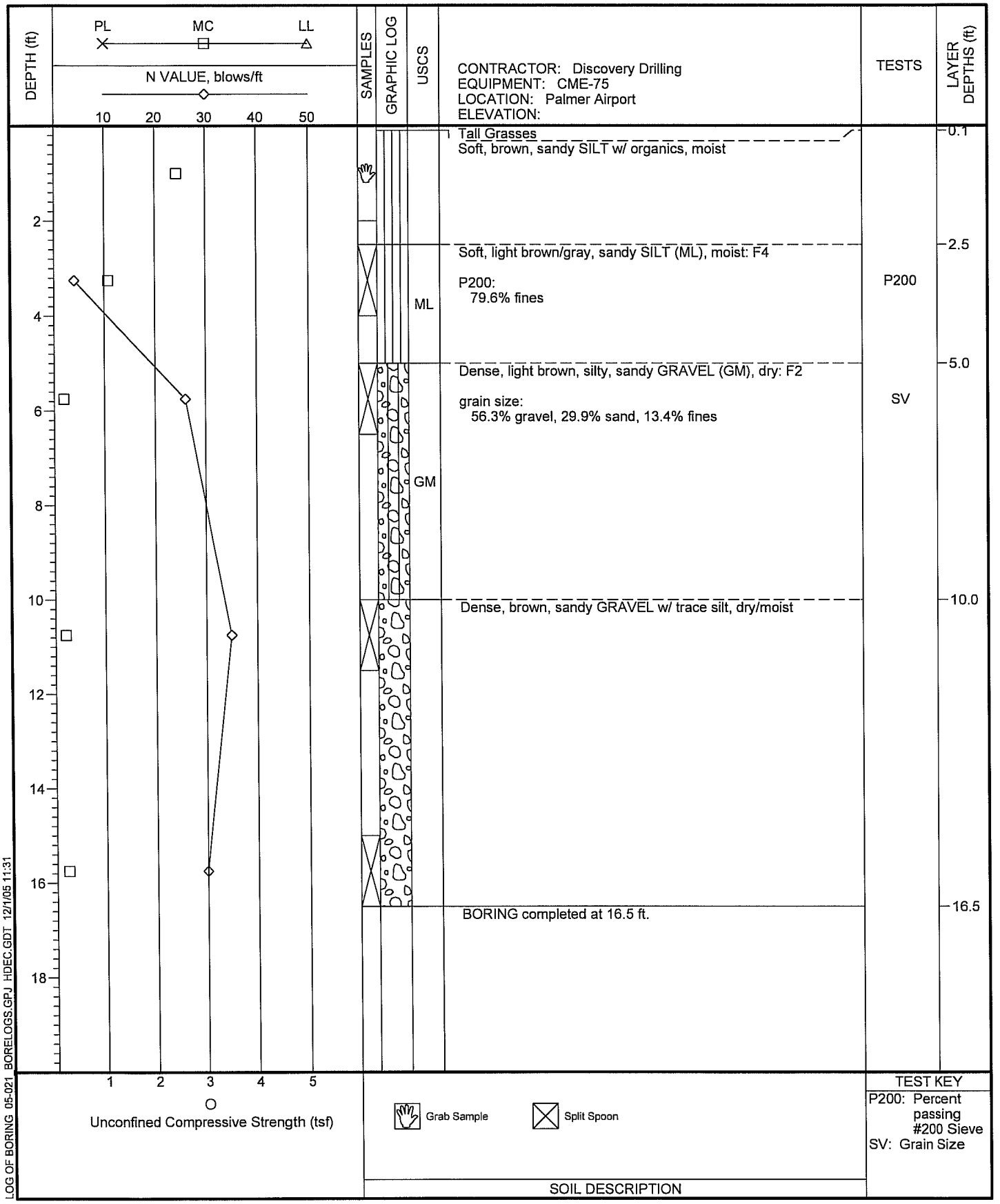
DATE DRILLED: September 21, 2005

SHEET TITLE: Figure A-16
SHEET: 1 of 1
JOB NUMBER: 05-021



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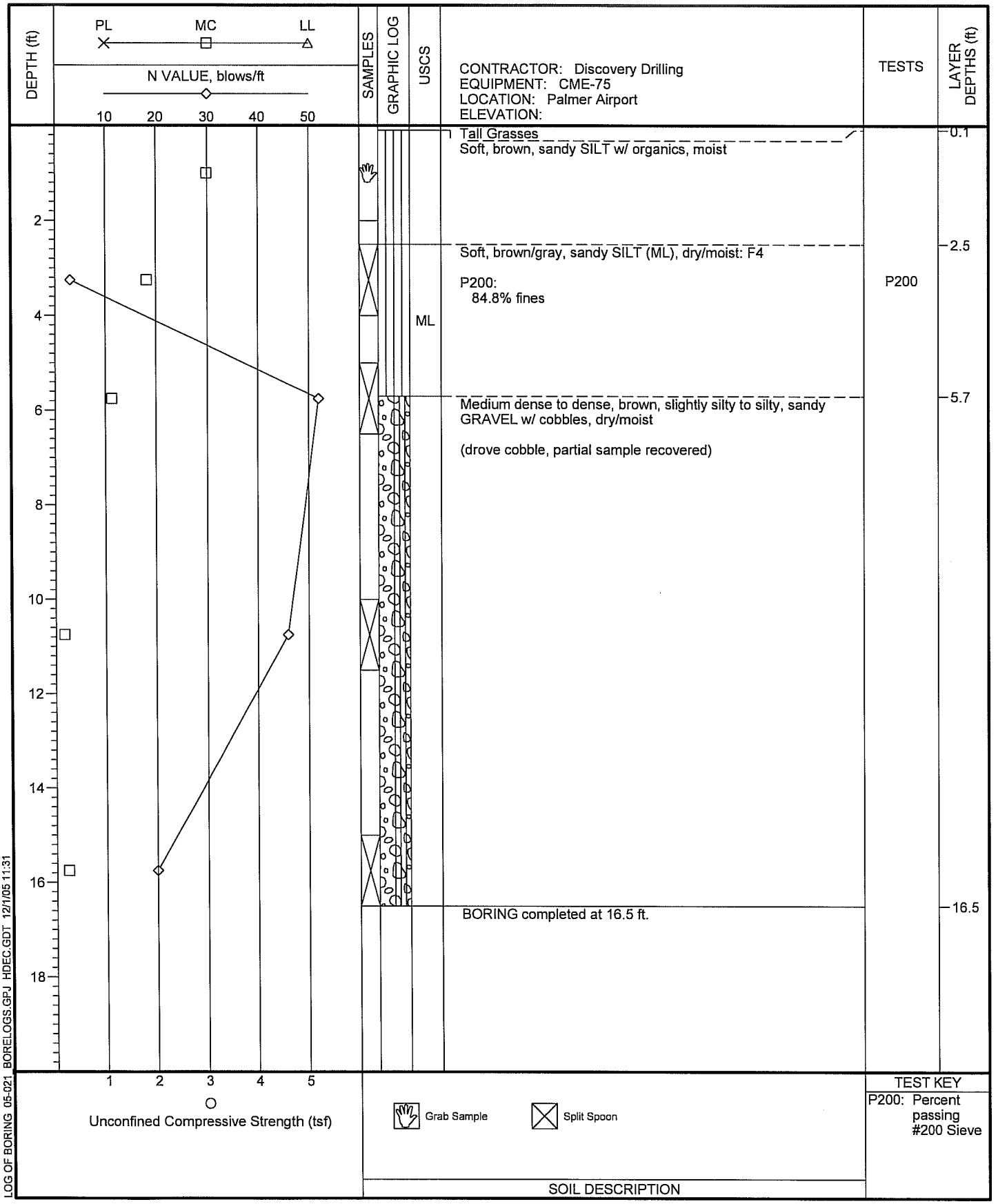
SHEET TITLE: Figure A-17
SHEET: 1 of 1
JOB NUMBER: 05-021



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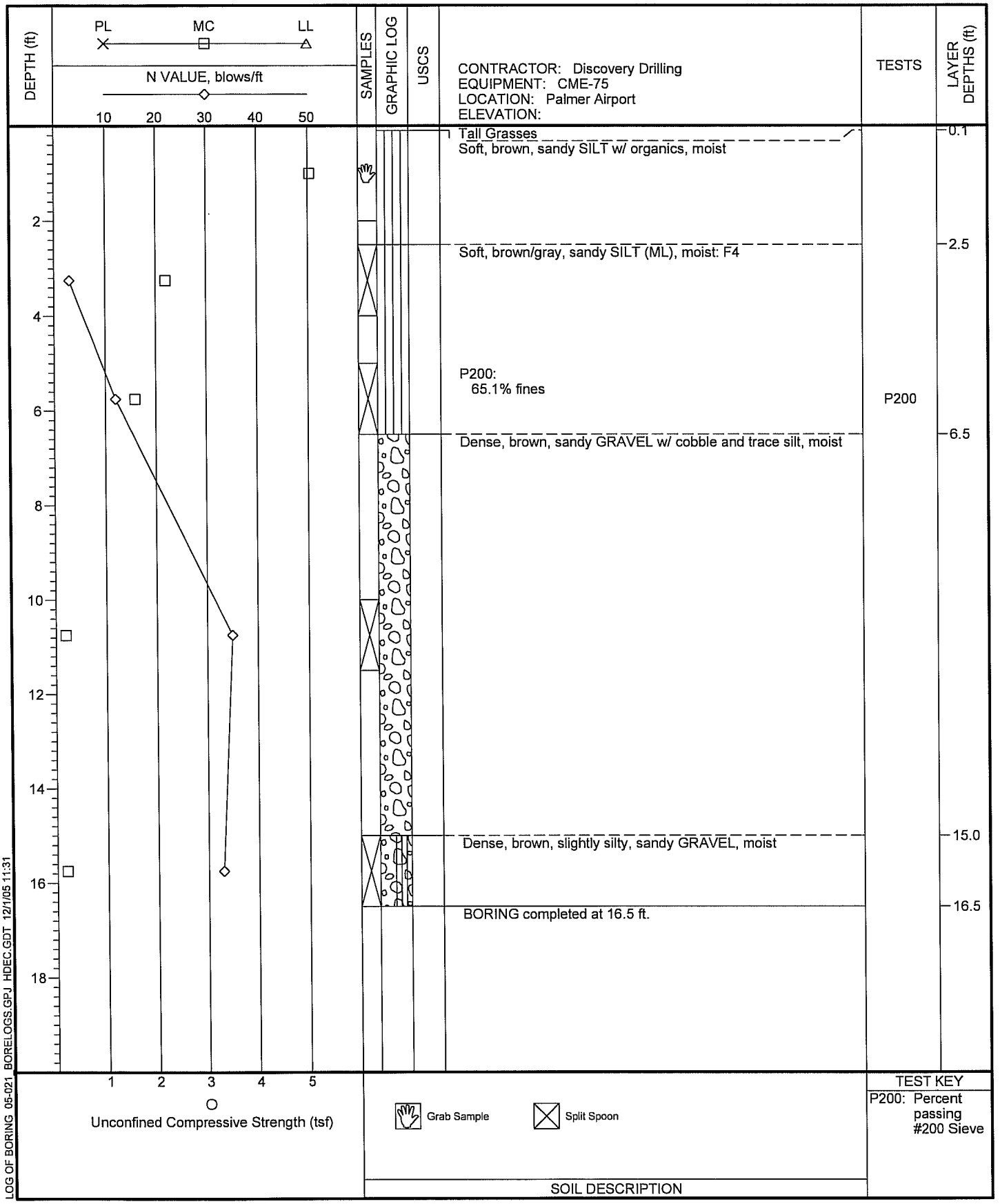
LOG OF BORING BH-16
LOGGED BY: M. Dale Butikofer
DATE DRILLED: September 22, 2005

SHEET TITLE: Figure A-18
SHEET: 1 of 1
JOB NUMBER: 05-021



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LOG OF BORING BH-17
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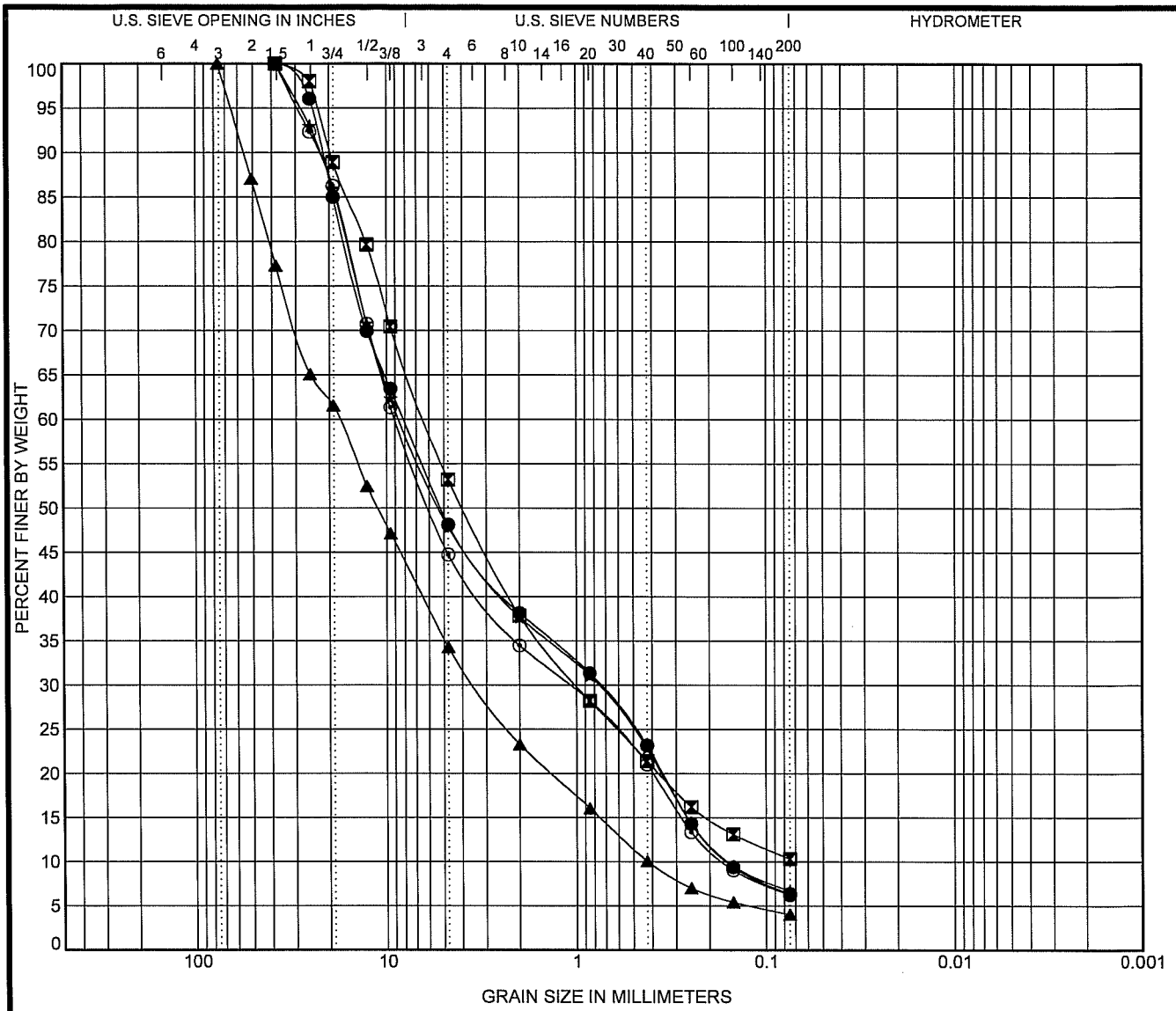
DATE DRILLED: September 22, 2005

SHEET TITLE: Figure A-19
SHEET: 1 of 1
JOB NUMBER: 05-021



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● BH-01	Depth 0.2	slightly silty, sandy GRAVEL (GP-GM)				0.44	50.99
⊠ BH-02	Depth 0.2	slightly silty, sandy GRAVEL (GW-GM)				2.30	90.50
▲ BH-04	Depth 10.0	sandy GRAVEL (GW) w/ trace silt				1.54	42.33
★ BH-06	Depth 0.2	slightly silty, sandy GRAVEL (GP-GM)				0.45	53.95
⊙ BH-07	Depth 0.2	slightly silty, sandy GRAVEL (GP-GM)				0.78	53.68

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● BH-01	Depth 0.2	38.1	8.152	0.758	0.16	51.9	41.7	6.4	
⊠ BH-02	Depth 0.2	38.1	6.25	0.996		46.8	42.9	10.3	
▲ BH-04	Depth 10.0	76.2	17.813	3.395	0.421	65.2	30.2	4.0	
★ BH-06	Depth 0.2	38.1	8.511	0.775	0.158	52.1	41.1	6.7	
⊙ BH-07	Depth 0.2	38.1	9.004	1.083	0.168	55.3	38.5	6.2	

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GRAIN SIZE DISTRIBUTION

Palmer Airport Rehabilitation

City of Palmer — Figure A-20

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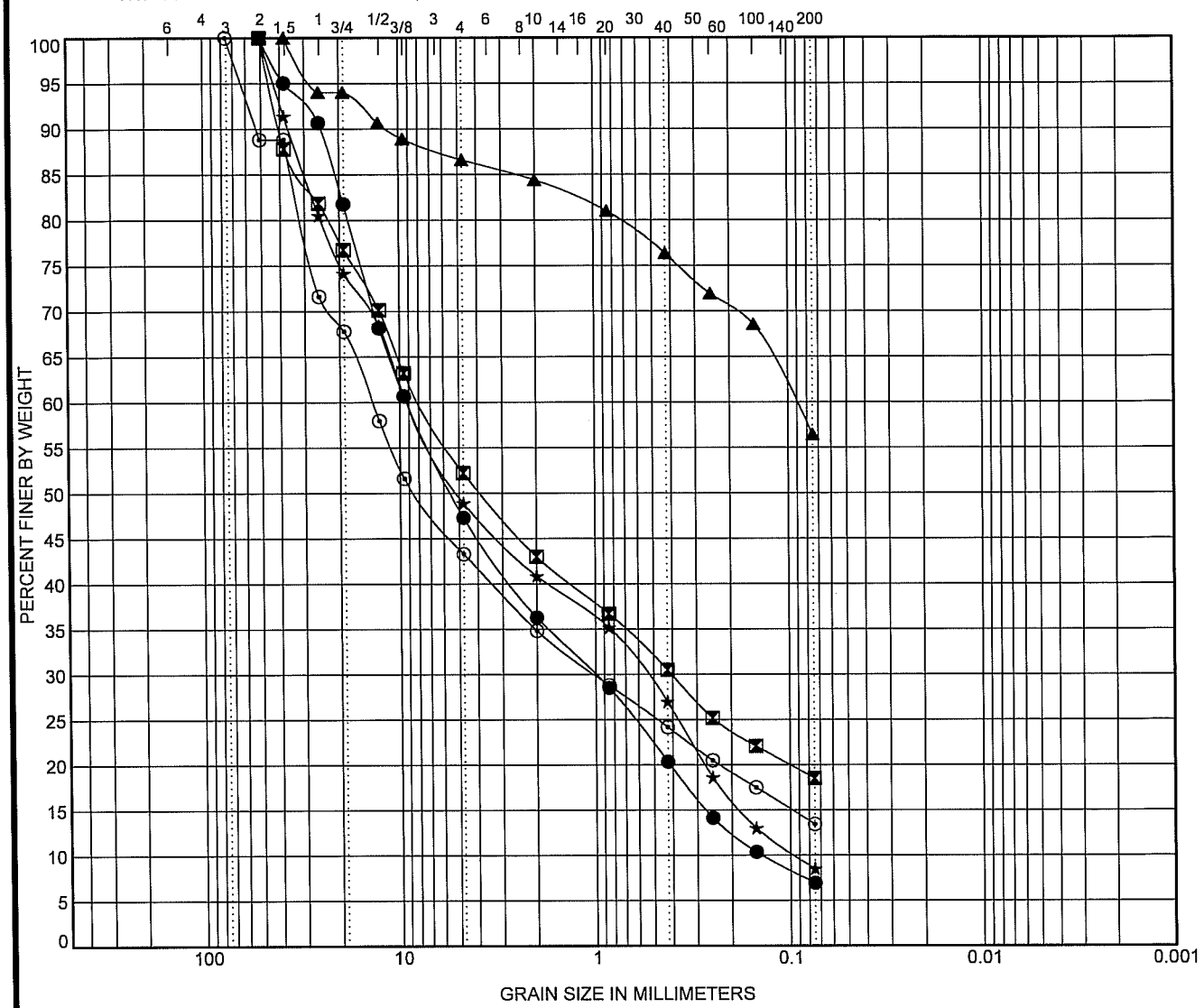

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● BH-10	Depth 0.2	slightly silty, sandy GRAVEL (GP-GM)				0.78	66.02
⊠ BH-12	Depth 0.2	silty, sandy GRAVEL (GM)					
▲ BH-13	Depth 1.8	gravelly, sandy SILT (ML)					
★ BH-14	Depth 0.2	slightly silty, sandy GRAVEL (GP-GM)				0.35	97.12
⊙ BH-15	Depth 5.0	silty, sandy GRAVEL (GM)					

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● BH-10	Depth 0.2	50.8	9.2	1.001	0.139	52.7	40.4	6.9	
⊠ BH-12	Depth 0.2	50.8	7.775	0.404		47.8	33.7	18.5	
▲ BH-13	Depth 1.8	38.1	0.092			13.4	30.2	56.4	
★ BH-14	Depth 0.2	50.8	9.16	0.549	0.094	51.1	40.4	8.5	
⊙ BH-15	Depth 5.0	76.2	13.818	1.01		56.3	29.9	13.4	

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GRAIN SIZE DISTRIBUTION

Palmer Airport Rehabilitation

City of Palmer — Figure A-21

Palmer, Alaska — 05-021

GRAIN SIZE 05-021 BORELOGS.GPJ HDEC.GDT 11/14/05 10:24

Appendix C

Boring Log Key

Frost Design Soil Classification System

Description and Classification of Frozen Soils

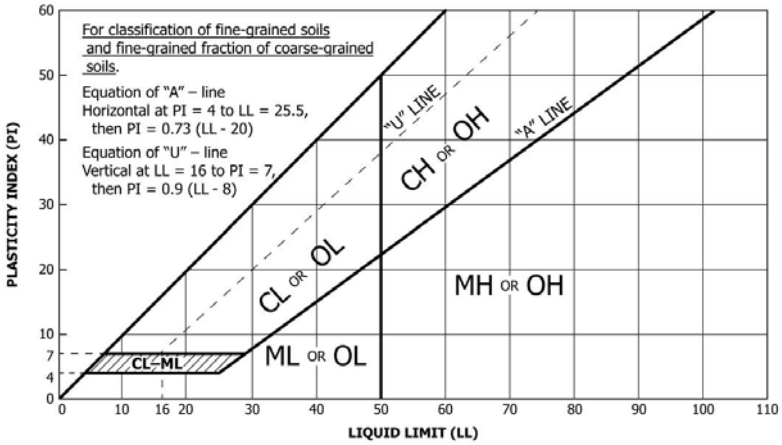
Peat and Organic Soil Classification System

BORING LOG KEY

Summary of the Unified Soil Classification System (from ASTM International Standard D2487)[A]				Soil Classification	
				Group Symbol	Group Name[B]
Coarse-grained Soils (*More than 50% retained on No. 200 sieve*)	Gravels (*More than 50% of coarse fraction retained on No. 4 sieve*)	Gravels with < 5% fines[C]	$C_u \geq 4$ and $1 \leq C_c \leq 3$[D]	GW	Well-graded gravel[E]
			$C_u < 4$ and/or [$C_c < 1$ or $C_c > 3$][D]	GP	Poorly graded gravel[E]
		Gravels with > 12% fines[C]	Fines classify as ML or MH	GM	Silty gravel[E,F,G]
			Fines classify as CL or CH	GC	Clayey gravel[E,F,G]
	Sands (*50% or more of coarse fraction passes No. 4 sieve*)	Sands with < 5% fines[H]	$C_u \geq 6$ and $1 \leq C_c \leq 3$[D]	SW	Well-graded sand[I]
			$C_u < 6$ and/or [$C_c < 1$ or $C_c > 3$][D]	SP	Poorly graded sand[I]
		Sands with > 12% fines[H]	Fines classify as ML or MH	SM	Silty sand[F,G,I]
			Fines classify as CL or CH	SC	Clayey sand[F,G,I]
Fine-grained Soils (*More than 50% passes the No. 200 sieve*)	Silts and Clays (*LL<50*)	Inorganic	PI>7 and plots on or above "A" line[J]	CL	Lean clay[K,L,M]
			PI<4 or plots below "A" line[J]	ML	Silt[K,L,M]
		Organic	LL - Oven dried/LL - Not dried <0.75	OL	Organic clay/silt[K,L,M,N/O]
	Silts and Clays (*LL≥50*)	Inorganic	PI plots on or above "A" line	CH	Fat clay[K,L,M]
			PI plots below "A" line	MH	Elastic silt[K,L,M]
		Organic	LL - Oven dried/LL - Not dried <0.75	OH	Organic clay/silt[K,L,M,P/Q]
Highly Organic Soils	Primarily organic matter, dark in color, and organic odor			PT	Peat

NOTES:
Visual soil descriptions performed in accordance with ASTM D2488
Lowercase USCS abbreviation indicates field classification
Uppercase USCS abbreviation indicates laboratory classification

[A]Based on the material passing the 3-in. (75-mm) sieve
[B]If field sample contained cobble or boulders, or both, add "with cobbles or boulders, or both" to group name
[C]Gravels with 5 to 12% fines require dual symbols:
GW-GM well-graded gravel with silt
GW-GC Well-graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay
[D] $C_u = D_{60}/D_{10}$, $C_c = (D_{30})^2/(D_{10} \times D_{60})$
[E]If soil contains ≥ 15% sand, add "with sand" to group name
[F]If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM
[G]If fines are organic, add "with organic fines" to group name
[H]Sands with 5 to 12% fines require dual symbols:
SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay
[I]If soil contains ≥15% gravel, add "with gravel" to group name
[J]If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay
[K]If soil contains 15 to < 30% plus No. 200, add "with sand" or "with gravel", whichever is predominant
[L]If soil contains ≥ 30% plus No. 200, predominantly sand, add "sandy" to group name
[M]If soil contains ≥ 30% plus No. 200, predominatly gravel, add "gravelly" to group name
[N]PI ≥ 4 and plots on or above "A" line
[O]PI < 4 or plots below "A" line
[P]PI plots on or above "A" line
[Q]PI plots below "A" line



GRAIN SIZE		
Size Class	Inches	mm
Boulders	>12 inches	>300
Cobbles	3 to 12	75 - 300
Gravel		
Coarse	3/4 - 3	19.0 - 75
Fine	3/16 - 3/4	4.76 - 19.0
Sand		
Coarse	1/16 - 3/16	2.0 - 4.76
Medium	1/64 - 1/16	0.42 - 2.0
Fine	1/256 - 1/64	0.074 - 0.42
Silt and Clay	<1/256	<0.074

SAMPLE TYPES	
Symbol	Description
SS	Split Spoon
MSS	Modified Split Spoon
G	Grab
ST	Shelby Tube
GP	Push Sample
C	Core

SOIL CONSISTENCY		
Description	N-Value	Pocket Pen.
Very Soft	<2	<0.25
Soft	2 - 4	0.25 - 0.5
Medium	4 - 8	0.5 - 1.0
Stiff	8 - 15	1.0 - 2.0
Very Stiff	15 - 30	2.0 - 4.0
Hard	>30	>4.0

RELATIVE SOIL DENSITY	
Description	N-Value
Very Loose	0 - 4
Loose	5 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	>50

COMPONENT PROPORTION (Visual)	
Term	Range
Trace	0 - 5%
Little	5 - 15%
Some	15 - 30%
And	30 - 50%

FROST DESIGN SOIL CLASSIFICATION

US Army Corps of Engineers (USACE) Methodology

The following frost design soil classification was developed by the USACE for describing the potential frost susceptibility of soils. The standard is published in USACE, EM 1110-3-138, "Pavement Criteria for Seasonal Frost Conditions," April 1984.

FROST GROUP	GENERAL SOIL TYPE	% FINER THAN 0.02 mm BY WEIGHT	TYPICAL USCS SOIL CLASS
NFS(1)	(a) Gravels Crushed Stone Crushed Rock	0-1.5	GW, GP
	(b) Sands	0-3	SW, SP
PFS(2)	(a) Gravels Crushed Stone Crushed Rock	1.5 -3	GW, GP
	(b) Sands	3-10	SW, SP
S1	Gravelly Soils	3-6	GW, GP, GW-GM, GP-GM, GW-GC, GP-GC
S2	Sandy Soils	3-6	SW, SP, SW-SM, SP-SM, SW-SC, SP-SC
F1	Gravelly Soils	6-10	GM, GC, GW-GM, GP-GM, GW-GC, GP-GC
F2	(a) Gravelly Soils	10-20	GW, GP, GW-GM, GP-GM, GW-GC, GP-GC
	(b) Sands	6-15	SM, SW-SM, SP-SM, SC, SW-SC, SP-SC, SM-SC
F3	(a) Gravelly Soils	Over 20	GM, GC, GM-GC
	(b) Sands, except very fine silty sands	Over 15	SM, SC, SM-SC
	(c) Clays, PI>12	--	CL, CH
F4	(a) Silts	--	ML, MH, ML-CL
	(b) Very fine silty sands	Over 15	SM, SC, SM-SC
	(c) Clays, PI<12	--	CL, ML-CL
	(d) Varied clays or other fine-grained banded sediments	--	CL or CH layered with ML, MH, ML-CL, SM, SC, or SM-SC

(1) Non-frost susceptible

(2) Possibly frost susceptible, requires lab test for void ratio to determine frost design soil classificatIon. Gravel with void ratio > 0.25 would be NFS; Gravel with void ratio < 0.25 would be S1; Sands with void ratio > 0.30 would be NFS; Sands with void ratio < 0.30 would be S2 or F2

Alaska Department of Transportation and Public Facilities (DOT&PF) Methodology

As shown above, the USACE standard is based in part on the percentage of material finer than 0.02 mm ($P_{0.02}$). The DOT&PF modifies the USACE standard by referencing the percentage of material finer than the #200 sieve, which is 0.075 mm, (P_{200}) rather than 0.02 mm. As reported in the Alaska Flexible Pavement Guide, the P_{200} value is typically twice that of the $P_{0.02}$; therefore, DOT&PF considers material with less than 6% by weight passing the #200, non-frost susceptible (NFS).

Municipality of Anchorage (MOA) Methodology

The MOA uses a simplified method based on the USACE methodology noted above. The MOA method is detailed in the Design Criteria Manual and summarized below. Note that the MOA method uses the $P_{0.02}$ value rather than the P_{200} value.

FROST GROUP	SOIL TYPE	PERCENTAGE FINER THAN 0.02 MILLIMETER BY WEIGHT	TYPICAL SOIL TYPES UNDER UNIFIED SOIL CLASSIFICATION SYSTEM
NFS	a. Gravels	0 to 3	GW, GP
	b. Sands	0 to 3	SW, SP
F-1	Gravelly soils	3 to 10	GW, GP, GW-GM, GP-GM
F-2	a. Gravelly soils	10 to 20	GM, GW-GM, GP-GM
	b. Sands	3 to 15	SW, SP, SM, SW-SM, SP
F-3	a. Gravelly soils	Over 20	GM, GC
	b. Sands, except very fine silty sands	Over 15	SM, SC
	c. Clays, PI>12	--	CL, CH
F-4	a. All silts	--	ML, MH
	b. Very fine silty sands	Over 15	SM, SC
	c. Clays, PI<12	--	CL, CL-ML
	d. Varied clays and other fine-grained, banded sediments	--	CL, CL-ML
		--	CL, CH, ML, SM

* Municipality of Anchorage, Project Management & Engineering Department, Design Criteria Manual, January 2007.

DESCRIPTION AND CLASSIFICATION OF FROZEN SOILS

(Summarized from the Alaska Field Guide for Soil Classification)

PART I: Description of Soil Phase—Independent of Frozen State(a)

	Major Group		Sub-Group		Field Identification	Pertinent Properties of Frozen Materials which may be measured by physical tests to supplement field identification.	Guide for Construction on Soils Subject to Freezing and Thawing	
	Description	Designation	Description	Designation			Thaw Characteristics	Criteria
Part II: Description of Frozen Soil	Segregated ice is not visible by eye (b)	N	Poorly Bonded or Friable	Nf	Identify by visual examination. To determine presence of excess ice, use procedure under note (c) below and hand magnifying lens as necessary. For soils not fully saturated, estimate degree of ice saturation: Medium, Low. Note presence of crystals, or of ice coating around larger particles.	In-Place Temperature Density and Void Ratio a) In Frozen State b) After Thawing in Place Water Content (Total H_2O, including ice) a) Average b) Distribution Strength a) Compressive b) Tensile c) Shear d) Adfreeze Elastic Properties Plastic Properties Thermal Properties Ice Crystal Structure (using optional instruments.) a) Orientation of Axes b) Crystal size c) Crystal shape d) Pattern of Arrangement	Usually Thaw-Stable	The potential intensity of ice segregation in a soil is dependent to a large degree on its void sizes and may be expressed as an empirical function of grain size as follows: Most inorganic soils containing 3 percent or more of grains finer than 0.02 mm in diameter by weight are frost-susceptible. Gravels, well graded sands and silty sands, especially those approaching the theoretical maximum density curve, which contain 1.5 to 3 percent finer than 0.02 mm by weight without being frost-susceptible. However, their tendency to occur interbedded with other soils usually makes it impractical to consider them separately. Soils classed as frost-susceptible under the above criteria are likely to develop significant ice segregation and frost heave if frozen at normal rates with free water readily available. Soils so frozen will fall into the thaw-unstable category. However, they may also be classed as thaw-stable if frozen with insufficient water to permit ice segregation. Soils classed as non-frost-susceptible (*NFS) under the above criteria usually occur without significant ice segregation and are not exact and may be inadequate for some structure applications: exceptions may also result from minor soil variations. In permafrost areas, ice wedges, pockets, veins, or other ice bodies may be found whose mode of origin is different from that described above. Such ice may be the result of long-time surface expansion and contraction phenomena or may be glacial or other ice which has been buried under a protective earth cover.
			No excess ice Well Bonded *Excess Ice*	Nb n Nb e				
	Segregated ice is visible by eye. (Ice 1 inch or less in thickness) (b)	V	Individual ice crystals or inclusions	Vx	For ice phase, record the following as applicable: Location, Size, Orientation, Shape Thickness, Spacing, Pattern of arrangement, Length Hardness, Structure, Color } per part III Below Estimate volume of visible segregated ice present as percent of total sample volume		Usually Thaw-Unstable	
			Ice coatings on particles	Vc				
			Random or irregularly oriented ice formations	Vr				
			Stratified or distinctly oriented ice formations	Vs				
Part III: Description of Substantial Ice Strata	Ice (Greater than 1 inch in thickness)	Ice	Ice with soil inclusions	Ice + Soil Type	Designate material as ICE (d) and use descriptive terms as follows, usually one item from each group, as applicable: Hardness: Hard, Soft (mass, not indi-crystals) Structure: Clear, Cloudy, Porous, Candled, Granular, Stratified Color: e.g.: Color-less, Gray, Blue Admixtures: e.g.: Contains Thin Silt Inclusions			
			Ice without soil inclusions	Ice				

DEFINITIONS:

Ice Coatings on Particles are discernible layers of ice found on or below the larger soil particles in a frozen soil mass. They are sometimes associated with hoarfrost crystals, which have grown into voids produced by the freezing action.

Ice Crystal is a very small individual ice particle visible in the face of a soil mass. Crystals may be present alone or in a combination with other ice formations.

Clear Ice is transparent and contains only a moderate number of air bubbles. (e)

Cloudy Ice is translucent, but essentially sound and non-pervious.

Porous Ice contains numerous voids, usually interconnected and usually resulting from melting at air bubbles or along crystal interfaces from presence of salt or other materials in the water, or from the freezing of saturated snow. Though porous, the mass retains its structural unity.

Candled Ice is ice which has rotted or otherwise formed long columnar crystals, very loosely bonded together.

Granular Ice is composed of coarse, more or less equidimensional, ice crystals weakly bonded together.

Ice Lenses are lenticular ice formations in soil occurring essentially parallel to each other, generally normal to the direction of heat loss and commonly in repeated layers.

Ice Segregation is the growth of ice as distinct lenses, layers, veins, and masses in soils, commonly but not always oriented normal to direction of heat loss.

Well-bonded signifies that the soil particles are strongly held together by the ice and that the frozen soil possesses relatively high resistance to chipping or breaking.

Poorly-bonded signifies that the soil particles are weakly held together by the ice and that the frozen soil consequently has poor resistance to chipping or breaking.

Friable denotes a condition in which material is easily broken up under light to moderate pressure.

Thaw-Stable frozen soils do not, on thawing, show loss of strength below normal, long-time thawed values nor produce detrimental settlement.

Thaw-Unstable frozen soils show on thawing, significant loss of strength below normal, long-time thawed values and/or significant settlement, as a direct result of the melting of the excess ice in the soil.

NOTES:

(a) When rock is encountered, standard rock classification terminology should be used.

(b) Frozen soils in the N group may on close examination indicate presence of ice within the voids of the material by crystalline reflections or by a sheen on fractured or trimmed surfaces. However, the impression to the unaided eye is that none of the frozen water occupies space in excess of the original voids in the soil. The opposite is true of frozen soils in the V group.

(c) When visual methods may be inadequate, a simple field test to aid evaluation of volume of excess ice can be made by placing some frozen soil in a small jar, allowing it to melt and observing the quantity of supernatant water as a percent of total volume.

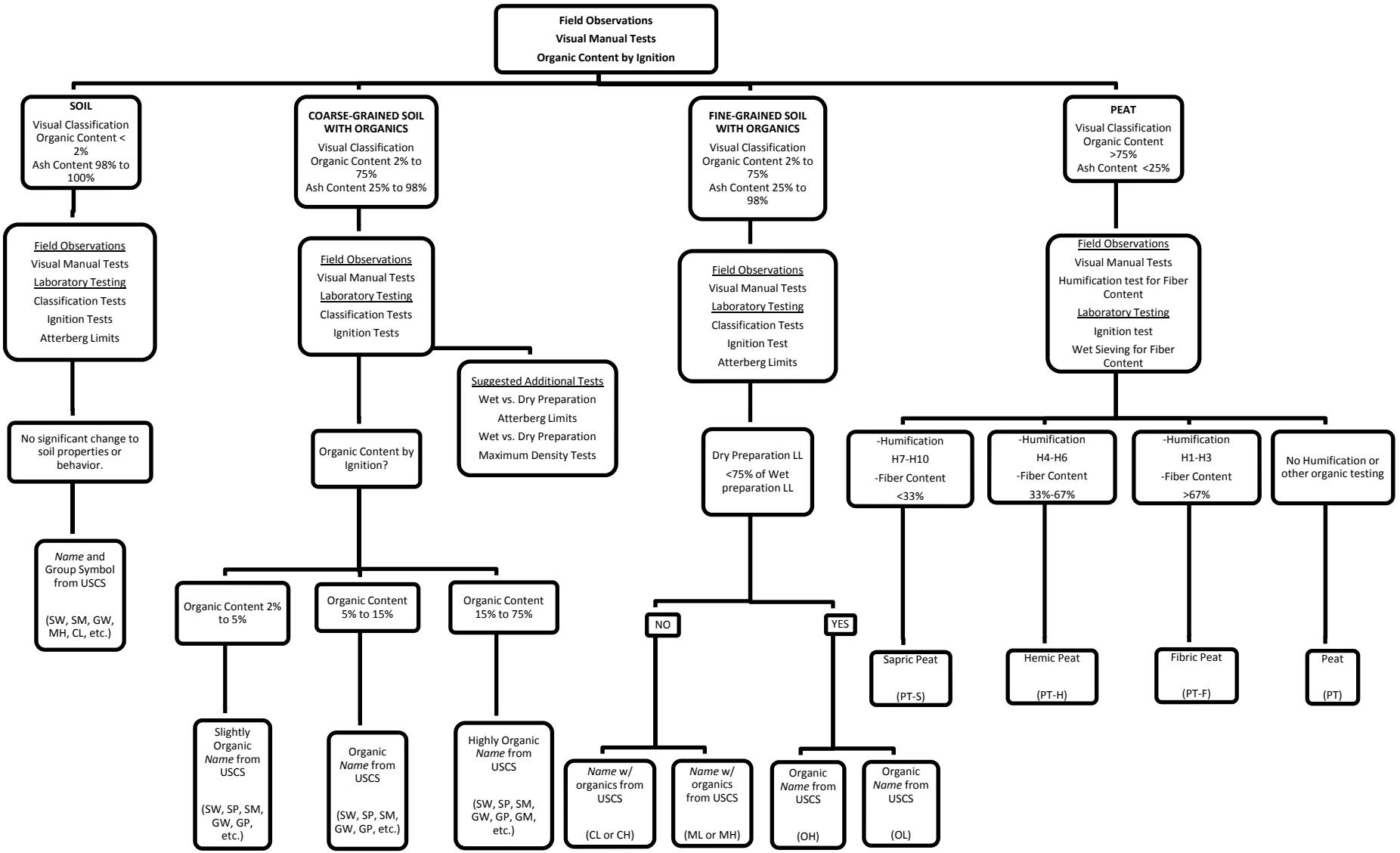
(d) Where special forms of ice, such as hoarfrost, can be distinguished, more explicit description should be given.

(e) Observer should be careful to avoid being misled by surface scratches or frost coating on the ice.

Modified from: Linell, K.A. and Kaplar, C.W., 1966, *Description and Classification of Frozen Soils*, Proc. International Conference on Permafrost (1963), Lafayette, IN, U.S. National Academy of Sciences, Publ. 1287, pp 481-487.

PEAT AND ORGANIC SOIL CLASSIFICATION SYSTEM

(Summarized from Alaska Guide for Classification of Peat and Organic Soil)



INCREASING ORGANIC CONTENT

Appendix D

Boring Logs

Test Pit Logs

HDL ENGINEERING Consultants LLC

LOG OF BORING

Hole #:**HDL-01**

PROJECT NUMBER : *18-001-15*
PROJECT : *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Station / Location: *near Taxiway J extension*
Lat/Long: *61.595526/-149.09918*
Elevation:

Equipment Type: *CME 75*
Field Crew: *Discovery Drilling*
Geologist: *J. LaBelle*

Total Depth: *11.3 feet*
Date: *11/4/2021*

Ground Water Data		
Depth (feet)		
Time		
Date		
Symbol		

Depth (Feet)	Drilling Method	Sample Data: Sample Type	Sample Data: Number	Sample Data: Blow Count	Sample Data: Sample	Sample Data: Recovery	Sample Data: N-Value	USCS Classification Bonded Zone	Soil Graphic	SUBSURFACE MATERIAL	
0	Hollow-Stem Auger	MSS	S-1	1				ml		ORGANIC MAT	0.0
0.3										SILT, (ml); little sand, fine; trace gravel, fine; trace organics; brown to grayish brown, dry, very loose, F4 Moisture =34.9%	
1				1							
2				3			4				
3				3							
4		MSS	S-2	1						P200 =84.4%, Sa =13.5%, Gr =2.1%, Moisture =36.6%, Org =4.9%	
5				1							
5.0				1							
6		MSS	S-3	2			3			moist Moisture =28.2%	
6.0				2							
7				10							
7.5				12			22	gp-gm		Poorly-graded GRAVEL, (gp-gm); fine to coarse; subangular to subrounded, with sand, fine to coarse; little silt; gray, dry, broken cobble in sample Moisture =3.2%	
8				20							
9		MSS	S-4	13				sp-sm		Poorly-graded SAND, (sp-sm); fine to coarse; with gravel, fine to coarse; subangular to subrounded; little silt; gray, dry refusal 50/4", Moisture =3.2%	
10				12							
11		MSS	S-5	12						refusal 50/3", Moisture =2.9%	
11.3				25					BOH 11.3		

Notes:
No free groundwater encountered.

☒ Auto Hammer ☐ Cathead Rope Method ☐ 140 lb. hammer with 30 in. drop ☒ 340 lb. hammer with 30 in. drop

HDL ENGINEERING Consultants LLC

LOG OF BORING

Hole #:**HDL-02**

PROJECT NUMBER : *18-001-15*
PROJECT : *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Station / Location: *near Taxiway J extension*
Lat/Long: *61.595466/-149.093045*
Elevation:

Equipment Type: *CME 75*
Field Crew: *Discovery Drilling*
Geologist: *J. LaBelle*

Total Depth: *12.0 feet*
Date: *11/4/2021*

Ground Water Data		
Depth (feet)		
Time		
Date		
Symbol		

Depth (Feet)	Drilling Method	Sample Data: Sample Type	Sample Data: Number	Sample Data: Blow Count	Sample Data: Sample	Sample Data: Recovery	Sample Data: N-Value	USCS Classification Bonded Zone	Soil Graphic	SUBSURFACE MATERIAL
0	Hollow-Stem Auger	MSS	S-1	1 1 3 3			4	ml		ORGANIC MAT — 0.0
1										SILT, (ml); little to some sand, fine; little to some organics; brown, dry Moisture =23.5% — 0.7
2										
3		MSS	S-2	1 2 1 2			3	ml		SILT, (ml); little sand, fine; trace to little organics; brown to grayish brown, dry, very loose, F4 P200 =87.5%, Sa =12.5%, Gr =0.0%, Moisture =25.3% — 2.5
4										
5		MSS	S-3	7 13 23 29			36	sw-sm		Well-graded SAND, (sw-sm); fine to coarse; with gravel, fine to coarse; subangular to subrounded; little silt; trace organics; brownish gray, dry, dense, broken cobble in sample Moisture =3.3% — 5.0
6										
7										very dense, F2 — 7.5
8		MSS	S-4	47 14 37 25			51			P200 =10.2%, Sa =47.6%, Gr =42.2%, Moisture =3.5%
9										
10		MSS	S-5	5 23 36 45			59			Moisture =2.1%
11										
12									BOH 12	Notes: No free groundwater encountered. — 12.0

☒ Auto Hammer ☐ Cathead Rope Method ☐ 140 lb. hammer with 30 in. drop ☒ 340 lb. hammer with 30 in. drop

HDL ENGINEERING Consultants LLC

LOG OF BORING

Hole #:**HDL-03**

PROJECT NUMBER : *18-001-15*
PROJECT : *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Station / Location: *near Taxiway J extension*
Lat/Long: *61.595437/-149.091486*
Elevation:

Equipment Type: *CME 75*
Field Crew: *Discovery Drilling*
Geologist: *J. LaBelle*

Total Depth: *12.0 feet*
Date: *11/4/2021*

Ground Water Data		
Depth (feet)		
Time		
Date		
Symbol		

Depth (Feet)	Drilling Method	Sample Data: Sample Type	Sample Data: Number	Sample Data: Blow Count	Sample Data: Sample	Sample Data: Recovery	Sample Data: N-Value	USCS Classification Bonded Zone	Soil Graphic	SUBSURFACE MATERIAL
0	Hollow-Stem Auger	MSS	S-1	1 1 2 2			3	ml		ORGANIC MAT 0.0
0.7										SILT, (ml); little sand, fine; trace organics; brown to brownish gray, dry Moisture =25.3%
2.5		MSS	S-2	1 2 2 2			4			very loose, F4 P200 =85.9%, Sa =14.0%, Gr =0.1%, Moisture =20.4%, Org =4.7%
5.4		MSS	S-3	3 22 25 26			47	gm		Poorly-graded GRAVEL, (gm); fine to coarse; subangular to subrounded, with sand, fine to coarse; little silt; brown, dry, dense, F2, broken cobble in sample P200 =13.8%, Sa =39.1%, Gr =47.1%, Moisture =4.7%
7.5		MSS	S-4	5 12 15 15			27			medium dense Moisture =1.9%
10		MSS	S-5	9 14 10 12			24			Moisture =2.1%
12									BOH 12	12.0

Notes:
No free groundwater encountered.

☒ Auto Hammer ☐ Cathead Rope Method ☐ 140 lb. hammer with 30 in. drop ☒ 340 lb. hammer with 30 in. drop

HDL ENGINEERING Consultants LLC

LOG OF BORING

Hole #:**HDL-04**

PROJECT NUMBER : *18-001-15*
PROJECT : *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Station / Location: *Taxiway B*
Lat/Long: *61.593719/-149.091398*
Elevation:

Equipment Type: *CME 75*
Field Crew: *Discovery Drilling*
Geologist: *J. LaBelle*

Total Depth: *4.0 feet*
Date: *11/4/2021*

Depth (Feet)	Drilling Method	Sample Data: Sample Type	Sample Data: Number	Sample Data: Blow Count	Sample Data: Sample	Sample Data: Recovery	Sample Data: N-Value	USCS Classification Bonded Zone	Soil Graphic	SUBSURFACE MATERIAL
0	Continuous MPT Sampling	MSS	S-1	3				gw-gm		Well-graded GRAVEL, (gw-gm); fine to coarse; subangular to subrounded, with sand, fine to coarse; little silt; brown, dry, loose, F1 P200 =7.7%, Sa =45.4%, Gr =46.9%, Moisture =4.3%
1				4						
				5			9			
2				3						
				3						
3		MSS	S-2	4						0.0
				3			7	ml		SILT, (ml); with sand, fine to coarse; trace gravel, fine; brown, dry to moist Moisture =29.7%
4				1					BOH 4	2.9 4.0 Notes: No free groundwater encountered.

Ground Water Data		
Depth (feet)		
Time		
Date		
Symbol		

☒ Auto Hammer ☐ Cathead Rope Method ☐ 140 lb. hammer with 30 in. drop ☒ 340 lb. hammer with 30 in. drop

HDL ENGINEERING Consultants LLC

LOG OF BORING

Hole #:**HDL-05**

PROJECT NUMBER : *18-001-15*
PROJECT : *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Station / Location: *Taxiway B*
Lat/Long: *61.594002/-149.092705*
Elevation:

Equipment Type: *CME 75*
Field Crew: *Discovery Drilling*
Geologist: *J. LaBelle*

Total Depth: *4.0 feet*
Date: *11/4/2021*

Depth (Feet)	Drilling Method	Sample Data: Sample Type	Sample Data: Number	Sample Data: Blow Count	Sample Data: Sample	Sample Data: Recovery	Sample Data: N-Value	USCS Classification Bonded Zone	Soil Graphic	Ground Water Data			SUBSURFACE MATERIAL
										Depth (feet)			
										Time			
										Date			
										Symbol			
0	Continuous MPT Sampling	MSS	S-1	2				sp-sm					Poorly-graded SAND, (sp-sm); fine to coarse; some gravel, fine; little silt; brown, dry 0.0
				1									Moisture =6.0%
				2			3	ml					SILT, (ml); little sand, fine; trace organics; light brown to brown, dry, very loose, F4 0.5
1				2									P200 =89.1%, Sa =10.9%, Gr =0.0%, Moisture =34.5%
				2									
2				2									Moisture =34.3%
		MSS	S-2	1									
3				2			3						
				6									
4									BOH 4				Notes: 4.0
													No free groundwater encountered.

☒ Auto Hammer ☐ Cathead Rope Method ☐ 140 lb. hammer with 30 in. drop ☒ 340 lb. hammer with 30 in. drop

Sheet Number 1 of 1

A USCS LOG OF TEST HOLE 18-001-15 PALMER TW N APRON E.GPJ HDL MODIFIED.GDT 7/19/22

HDL ENGINEERING Consultants LLC

LOG OF BORING

Hole #:**HDL-06**

PROJECT NUMBER : *18-001-15*
PROJECT : *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Station / Location: *Taxiway B*
Lat/Long: *61.594487/-149.095003*
Elevation:

Equipment Type: *CME 75*
Field Crew: *Discovery Drilling*
Geologist: *J. LaBelle*

Total Depth: *4.0 feet*
Date: *11/4/2021*

Depth (Feet)	Drilling Method	Sample Data: Sample Type	Sample Data: Number	Sample Data: Blow Count	Sample Data: Sample	Sample Data: Recovery	Sample Data: N-Value	USCS Classification Bonded Zone	Soil Graphic	Ground Water Data			SUBSURFACE MATERIAL
										Depth (feet)			
										Time			
										Date			
										Symbol			
0	Continuous MPT Sampling	MSS	S-1	3				sw-sm					Well-graded SAND, (sw-sm); fine to coarse; with gravel, fine to coarse; subangular to subrounded; little silt; trace organics; brown, dry, F2 P200 =7.4%, Sa =52.7%, Gr =39.9%, Moisture =6.8%
				2									0.0
1				2			4	ml					0.8 SILT, (ml); some sand, fine; little gravel, fine to coarse; trace organics; brown to brownish gray, dry, very loose, F4 P200 =73.6%, Sa =19.0%, Gr =7.4%, Moisture =33.4%
				2									
2				2									Moisture =35.4%
		MSS	S-2	2									
3				2			4						
				2									
4									BOH 4				4.0 Notes: No free groundwater encountered.

☒ Auto Hammer ☐ Cathead Rope Method ☐ 140 lb. hammer with 30 in. drop ☒ 340 lb. hammer with 30 in. drop

HDL ENGINEERING Consultants LLC

LOG OF BORING

Hole #:**HDL-07**

PROJECT NUMBER : *18-001-15*
PROJECT : *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Station / Location: *Taxiway B*
Lat/Long: *61.594958/-149.097285*
Elevation:

Equipment Type: *CME 75*
Field Crew: *Discovery Drilling*
Geologist: *J. LaBelle*

Total Depth: *4.0 feet*
Date: *11/4/2021*

Depth (Feet)	Drilling Method	Sample Data: Sample Type	Sample Data: Number	Sample Data: Blow Count	Sample Data: Sample	Sample Data: Recovery	Sample Data: N-Value	USCS Classification Bonded Zone	Soil Graphic	Ground Water Data		
										Depth (feet)		
										Time		
										Date		
										Symbol		

SUBSURFACE MATERIAL

Depth (Feet)	Drilling Method	Sample Type	Number	Blow Count	N-Value	USCS Classification Bonded Zone	Soil Graphic	SUBSURFACE MATERIAL
0	Continuous MPT Sampling	MSS	S-1	1 1 2 1	3	SP		Poorly-graded SAND, (SP); fine to coarse; with gravel, fine; trace silt; brown, dry, very loose, NFS P200 =4.8%, Sa =54.0%, Gr =41.2%, Moisture =4.0%
2		MSS	S-2	1 2 3 7	5	sm		0.0 SAND, (sm); fine to coarse; with gravel, fine; some to with silt; trace organics; brown, dry, loose, broken cobble in sample Moisture =15.8% 2.0
4							BOH 4	4.0 Notes: No free groundwater encountered.

☒ Auto Hammer ☐ Cathead Rope Method ☐ 140 lb. hammer with 30 in. drop ☒ 340 lb. hammer with 30 in. drop

HDL ENGINEERING Consultants LLC

LOG OF BORING

Hole #:**HDL-08**

PROJECT NUMBER : *18-001-15*
PROJECT : *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Station / Location: *near proposed Taxiway N*
Lat/Long: *61.594565/-149.100875*
Elevation:

Equipment Type: *CME 75*
Field Crew: *Discovery Drilling*
Geologist: *J. LaBelle*

Total Depth: *12.0 feet*
Date: *11/3/2021*

Ground Water Data		
Depth (feet)		
Time		
Date		
Symbol		

Depth (Feet)	Drilling Method	Sample Data: Sample Type	Sample Data: Number	Sample Data: Blow Count	Sample Data: Sample	Sample Data: Recovery	Sample Data: N-Value	USCS Classification Bonded Zone	Soil Graphic	SUBSURFACE MATERIAL	
0	Hollow-Stem Auger	MSS	S-1	1				ml		ORGANIC MAT	0.0
0.3										SILT, (ml); with sand, fine; trace organics; brownish gray, dry, very loose Moisture =36.7%	
1				1			3				
2				2							
3		MSS	S-2	5				GP			
3.3				8			19			Poorly-graded GRAVEL, (GP); fine to coarse; subangular to subrounded, with sand, fine to coarse; trace silt; gray, dry, medium dense, NFS P200 =3.4%, Sa =42.8%, Gr =53.8%, Moisture =1.8%	
4				11							
5				12							
5.0		MSS	S-3	6						broken cobble in sample Moisture =2.5%	
6				14			29				
7				15							
8		MSS	S-4	19						Refusal 50/5", Moisture =2.7%	
9				19							
10								sw-sm		Well-graded SAND, (sw-sm); fine to coarse; with gravel, fine to coarse; subangular to subrounded; little silt; gray, dry, medium dense, F2 P200 =7.7%, Sa =55.5%, Gr =36.8%, Moisture =3.2%	10.0
11		MSS	S-5	20							
12				14			28				
				14							
				12					BOH 12	Notes: No free groundwater encountered.	12.0

☒ Auto Hammer ☐ Cathead Rope Method ☐ 140 lb. hammer with 30 in. drop ☒ 340 lb. hammer with 30 in. drop

HDL ENGINEERING Consultants LLC

LOG OF BORING

Hole #:**HDL-09**

PROJECT NUMBER : *18-001-15*
PROJECT : *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Station / Location: *near proposed Taxiway N*
Lat/Long: *61.59412/-149.100719*
Elevation:

Equipment Type: *CME 75*
Field Crew: *Discovery Drilling*
Geologist: *J. LaBelle*

Total Depth: *12.0 feet*
Date: *11/3/2021*

Ground Water Data		
Depth (feet)		
Time		
Date		
Symbol		

Depth (Feet)	Drilling Method	Sample Data: Sample Type	Sample Data: Number	Sample Data: Blow Count	Sample Data: Sample	Sample Data: Recovery	Sample Data: N-Value	USCS Classification Bonded Zone	Soil Graphic	SUBSURFACE MATERIAL
0	Hollow-Stem Auger	MSS	S-1	1 1 3 5			4	ml		SILT, (ml); some sand, fine; trace organics; brown, dry, very loose Moisture =33.3%
3.3		MSS	S-2	1 1 3 2			4	ml		SILT, (ml); little sand, fine; little organics; brownish gray, dry, F4 P200 =88.2%, Sa =11.8%, Gr =0.0%, Moisture =31.7%, Org =5.3%
5.7		MSS	S-3	1 3 6 16			9	sm		SAND, (sm); fine to coarse; some silt; little gravel, fine to coarse; subangular; brown, dry, F3 P200 =18.1%, Sa =67.2%, Gr =14.7%, Moisture =8.3%
7.5		MSS	S-4	4 38 34 22			72	gp		Poorly-graded GRAVEL, (gp); fine to coarse; subangular to subrounded, with sand, fine to coarse; trace to little silt; grayish brown, dry, very dense, broken cobble in sample Moisture =1.8%
10.0		MSS	S-5	15 24 16 18			40	sp		Poorly-graded SAND, (sp); fine to coarse; with gravel, fine to coarse; subangular to subrounded; trace to little silt; brown, dry, dense
12.0									BOH 12	Notes: No free groundwater encountered.

☒ Auto Hammer ☐ Cathead Rope Method ☐ 140 lb. hammer with 30 in. drop ☒ 340 lb. hammer with 30 in. drop

HDL ENGINEERING Consultants LLC

LOG OF BORING

Hole #:**HDL-10**

PROJECT NUMBER : *18-001-15*
PROJECT : *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Station / Location: *near proposed Taxiway N*
Lat/Long: *61.593935/-149.09983*
Elevation:

Equipment Type: *CME 75*
Field Crew: *Discovery Drilling*
Geologist: *J. LaBelle*

Total Depth: *12.0 feet*
Date: *11/3/2021*

Ground Water Data		
Depth (feet)		
Time		
Date		
Symbol		

Depth (Feet)	Drilling Method	Sample Data: Sample Type	Sample Data: Number	Sample Data: Blow Count	Sample Data: Sample	Sample Data: Recovery	Sample Data: N-Value	USCS Classification Bonded Zone	Soil Graphic	SUBSURFACE MATERIAL
0	Hollow-Stem Auger	MSS	S-1	1 1 1 1			2	ml		SILT, (ml); some to with sand, fine; trace organics; brown, dry, very loose Moisture =34.4% — 0.0
2										
3		MSS	S-2	3 5 10 11			15	gw-gm		Well-graded GRAVEL, (gw-gm); fine to coarse; subangular to subrounded, with sand, fine to coarse; little silt; grayish brown, dry, medium dense, NFS P200 =6.0%, Sa =32.8%, Gr =61.2%, Moisture =4.0% — 2.8
5		MSS	S-3	16 20 17 17			37	sp-sm		Poorly-graded SAND, (sp-sm); fine to coarse; with gravel, fine to coarse; subangular to subrounded; trace to little silt; grayish brown, dry, dense Moisture =3.5% — 5.0
7		MSS	S-4	16 19 28 44			47			Moisture =4.0%
10		MSS	S-5	50 27 21 24			48			broken cobble in sample Moisture =3.5% — 10.0
12									BOH 12	Notes: No free groundwater encountered. — 12.0

☒ Auto Hammer ☐ Cathead Rope Method ☐ 140 lb. hammer with 30 in. drop ☒ 340 lb. hammer with 30 in. drop

HDL ENGINEERING Consultants LLC

LOG OF BORING

Hole #:**HDL-11**

PROJECT NUMBER : *18-001-15*
PROJECT : *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Station / Location: *near proposed Taxiway N*
Lat/Long: *61.593703/-149.098774*
Elevation:

Equipment Type: *CME 75*
Field Crew: *Discovery Drilling*
Geologist: *J. LaBelle*

Total Depth: *12.0 feet*
Date: *11/3/2021*

Ground Water Data		
Depth (feet)		
Time		
Date		
Symbol		

Depth (Feet)	Drilling Method	Sample Type	Number	Blow Count	Sample	Recovery	N-Value	USCS Classification Bonded Zone	Soil Graphic	SUBSURFACE MATERIAL
0	Hollow-Stem Auger	MSS	S-1	1 1 2 1			3	ml		SILT, (ml); little sand, fine; trace organics; brown, dry to moist, very loose Moisture =37.6%
3.1										
3		MSS	S-2	4 9 14 19			23	gp-gm		Poorly-graded GRAVEL, (gp-gm); fine to coarse; subangular to subrounded, with sand, fine to coarse; little silt; brown, dry, NFS P200 =5.6%, Sa =38.2%, Gr =56.2%, Moisture =4.3%
5.0										
5		MSS	S-3	6 17 18 24			35			dense, broken cobble in sample Moisture =5.2%
8		MSS	S-4	2 16 17 18			33			Moisture =3.0%
10		MSS	S-5	22 23 25 46			48			Moisture =2.3%
12									BOH 12	
12.0										Notes: No free groundwater encountered.

☒ Auto Hammer ☐ Cathead Rope Method ☐ 140 lb. hammer with 30 in. drop ☒ 340 lb. hammer with 30 in. drop

Sheet Number 1 of 1

A USCS LOG OF TEST HOLE 18-001-15 PALMER TW N APRON E.GPJ HDL MODIFIED.GDT 7/19/22

HDL ENGINEERING Consultants LLC

LOG OF BORING

Hole #:**HDL-12**

PROJECT NUMBER : *18-001-15*
PROJECT : *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Station / Location: *near proposed Taxiway N*
Lat/Long: *61.593464/-149.097692*
Elevation:

Equipment Type: *CME 75*
Field Crew: *Discovery Drilling*
Geologist: *J. LaBelle*

Total Depth: *10.4 feet*
Date: *11/3/2021*

Ground Water Data		
Depth (feet)		
Time		
Date		
Symbol		

Depth (Feet)	Drilling Method	Sample Data: Sample Type	Sample Data: Number	Sample Data: Blow Count	Sample Data: Sample	Sample Data: Recovery	Sample Data: N-Value	USCS Classification Bonded Zone	Soil Graphic	SUBSURFACE MATERIAL
0	Hollow-Stem Auger	MSS	S-1	1				ml		ORGANIC MAT — 0.0
0.1				0						SILT, (ml); some sand, fine; little organics; brown to brownish gray, dry, very loose Moisture =48.6%
1				3			3			
2				6						
2.5		MSS	S-2	2						F4 P200 =73.9%, Sa =26.1%, Gr =0.0%, Moisture =29.4%, Org =5.6%
3				2						
4				2			4			
5				1						
5.7		MSS	S-3	2				sp-sm		Poorly-graded SAND, (sp-sm); fine to coarse; some to with gravel, fine to coarse; subangular to subrounded; little silt; brown, dry Moisture =2.3%
6				10						
7				10			20			
7.5				13						
8		MSS	S-4	3						medium dense, broken cobble in sample Moisture =2.0%
9				6						
10				10			16			
		MSS	S-5	12						Refusal 50/5", Moisture =4.4%
10.4									BOH 10.4	Notes: No free groundwater encountered.

☒ Auto Hammer ☐ Cathead Rope Method ☐ 140 lb. hammer with 30 in. drop ☒ 340 lb. hammer with 30 in. drop

HDL ENGINEERING Consultants LLC

LOG OF BORING

Hole #:**HDL-13**

PROJECT NUMBER : *18-001-15*
PROJECT : *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Station / Location: *near proposed Taxiway N*
Lat/Long: *61.59327/-149.09664*
Elevation:

Equipment Type: *CME 75*
Field Crew: *Discovery Drilling*
Geologist: *J. LaBelle*

Total Depth: *12.0 feet*
Date: *11/3/2021*

Ground Water Data		
Depth (feet)		
Time		
Date		
Symbol		

Depth (Feet)	Drilling Method	Sample Data: Sample Type	Sample Data: Number	Sample Data: Blow Count	Sample Data: Sample	Sample Data: Recovery	Sample Data: N-Value	USCS Classification Bonded Zone	Soil Graphic	SUBSURFACE MATERIAL
0	Hollow-Stem Auger	MSS	S-1	1 1 1 0			2	ml		ORGANIC MAT 0.0 SILT, (ml); with sand, fine; trace to little organics; brown to grayish brown, dry to moist, very loose 0.1 Moisture =39.3%
3		MSS	S-2	1 8 10 13			18	GP		Poorly-graded GRAVEL, (GP); fine to coarse; subangular to subrounded, with sand, fine to coarse; trace silt; brownish gray, dry, NFS 3.3 P200 =4.4%, Sa =37.4%, Gr =58.2%, Moisture =3.5%
5		MSS	S-3	6 12 21 11			33			dense, broken cobble in sample 5.0 Moisture =3.4%
7		MSS	S-4	7 8 8 11			16			medium dense 7.5 Moisture =1.9%
10		MSS	S-5	48 7 17 35			24			Moisture =2.0%
12									BOH 12	12.0 Notes: No free groundwater encountered.

☒ Auto Hammer ☐ Cathead Rope Method ☐ 140 lb. hammer with 30 in. drop ☒ 340 lb. hammer with 30 in. drop

Sheet Number 1 of 1

A USCS LOG OF TEST HOLE 18-001-15 PALMER TW N APRON E.GPJ HDL MODIFIED.GDT 7/19/22

HDL ENGINEERING Consultants LLC

LOG OF BORING

Hole #:**HDL-14**

PROJECT NUMBER : *18-001-15*
PROJECT : *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Station / Location: *near proposed Taxiway N*
Lat/Long: *61.593077/-149.095534*
Elevation:

Equipment Type: *CME 75*
Field Crew: *Discovery Drilling*
Geologist: *J. LaBelle*

Total Depth: *12.0 feet*
Date: *11/3/2021*

Ground Water Data		
Depth (feet)		
Time		
Date		
Symbol		

Depth (Feet)	Drilling Method	Sample Data: Sample Type	Sample Data: Number	Sample Data: Blow Count	Sample Data: Sample	Sample Data: Recovery	Sample Data: N-Value	USCS Classification Bonded Zone	Soil Graphic	SUBSURFACE MATERIAL
0	Hollow-Stem Auger									ORGANIC MAT — 0.0
0.3										
1		MSS	S-1	1, 1, 1, 1			2	ml		SILT, (ml); some sand, fine; trace gravel, fine; trace organics; brown, dry to moist, very loose Moisture =39.3%
2										
2.5										F4 P200 =81.3%, Sa =17.1%, Gr =1.6%, Moisture =32.9%, Org =4.5%
3		MSS	S-2	1, 3, 16, 24			19	gw-gm		
3.6										Well-graded GRAVEL, (gw-gm); fine to coarse; angular to subrounded, some sand, fine to coarse; little silt; brownish gray, dry, F1, broken cobble in sample P200 =6.2%, Sa =27.9%, Gr =65.9%, Moisture =3.1%
5		MSS	S-3	8, 13, 13, 20			26	sp-sm		Poorly-graded SAND, (sp-sm); fine to coarse; with gravel, fine to coarse; angular to subrounded; little silt; brownish gray, dry, medium dense Moisture =3.6%
7.5		MSS	S-4	9, 8, 7, 12			15			broken cobble in sample Moisture =2.9%
10		MSS	S-5	8, 12, 18, 18			30			Moisture =3.2%
12									BOH 12	Notes: No free groundwater encountered. — 12.0

☒ Auto Hammer ☐ Cathead Rope Method ☐ 140 lb. hammer with 30 in. drop ☒ 340 lb. hammer with 30 in. drop

HDL ENGINEERING Consultants LLC

LOG OF BORING

Hole #:**HDL-15**

PROJECT NUMBER : *18-001-15*
PROJECT : *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Station / Location: *near proposed Taxiway N*
Lat/Long: *61.592852/-149.094279*
Elevation:

Equipment Type: *CME 75*
Field Crew: *Discovery Drilling*
Geologist: *J. LaBelle*

Total Depth: *12.0 feet*
Date: *11/3/2021*

Ground Water Data		
Depth (feet)		
Time		
Date		
Symbol		

Depth (Feet)	Drilling Method	Sample Data: Sample Type	Sample Data: Number	Sample Data: Blow Count	Sample Data: Sample	Sample Data: Recovery	Sample Data: N-Value	USCS Classification Bonded Zone	Soil Graphic	SUBSURFACE MATERIAL
0	Hollow-Stem Auger	MSS	S-1	1 1 1 1			2	ml		ORGANIC MAT 0.0 SILT, (ml); some sand, fine; trace organics; grayish brown, dry to moist, very loose 0.2 Moisture =37.0%
2		MSS	S-2	1 3 9 12			12	gp-gm		F4 2.5 P200 =81.1%, Sa =18.9%, Gr =0.0%, Moisture =30.0%, Org =4.1% Poorly-graded GRAVEL, (gp-gm); fine to coarse; angular to subrounded, with sand, fine to coarse; little silt; brownish gray, dry 3.7 Moisture =3.6%
5		MSS	S-3	6 18 21			39	GW		Well-graded GRAVEL, (GW); fine to coarse; angular to subrounded, with sand, fine to coarse; trace silt; brownish gray, dry, dense, NFS 5.0 refusal 50/5", P200 =2.9%, Sa =44.6%, Gr =52.5%, Moisture =4.0%
7		MSS	S-4	6 16 22 31			38			Moisture =3.9%
10		MSS	S-5	15 24 19 18			43			broken cobble in sample 10.0 Moisture =12.3%
12									BOH 12	12.0 Notes: No free groundwater encountered.

☒ Auto Hammer ☐ Cathead Rope Method ☐ 140 lb. hammer with 30 in. drop ☒ 340 lb. hammer with 30 in. drop

HDL ENGINEERING Consultants LLC

LOG OF BORING

Hole #:**HDL-16**

PROJECT NUMBER : *18-001-15*
PROJECT : *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Station / Location: *near proposed Taxiway N*
Lat/Long: *61.592624/-149.093261*
Elevation:

Equipment Type: *CME 75*
Field Crew: *Discovery Drilling*
Geologist: *J. LaBelle*

Total Depth: *12.0 feet*
Date: *11/3/2021*

Depth (Feet)	Drilling Method	Sample Type	Number	Blow Count	Sample	Recovery	N-Value	USCS Classification Bonded Zone	Soil Graphic	Ground Water Data			SUBSURFACE MATERIAL	
										Depth (feet)				
										Time				
										Date				
										Symbol				
0	Hollow-Stem Auger	MSS	S-1	2			2	ml					SILT, (ml); some to with sand, fine; trace organics; brown to grayish brown, dry, very loose Moisture =34.6%	0.0
1				1										
2				1										
3		MSS	S-2	2			4							
4				2				sm					SAND, (sm); fine to coarse; some silt; trace gravel, fine; trace organics; brown, dry, very loose, F3 P200 =26.0%, Sa =72.2%, Gr =1.8%, Moisture =15.1%, Org =1.6%	3.7
5				2										
6		MSS	S-3	3			18	gp-gm					Poorly-graded GRAVEL, (gp-gm); fine to coarse; angular to subrounded, with sand, fine to coarse; little silt; gray, dry Moisture =3.5%	6.1
7				9										
8				12									medium dense, broken cobble in sample Moisture =4.2%	7.5
9		MSS	S-4	4			28							
10				10									dense Moisture =2.8%	10.0
11		MSS	S-5	18			46							
12				16					BOH 12				Notes: No free groundwater encountered.	12.0
				9										
				18										
				28										
				24										

☒ Auto Hammer ☐ Cathead Rope Method ☐ 140 lb. hammer with 30 in. drop ☒ 340 lb. hammer with 30 in. drop

Sheet Number 1 of 1

A USCS LOG OF TEST HOLE 18-001-15 PALMER TW N APRON E.GPJ HDL MODIFIED.GDT 7/19/22

HDL ENGINEERING Consultants LLC

LOG OF BORING

Hole #:**HDL-17**

PROJECT NUMBER : *18-001-15*
PROJECT : *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Station / Location: *near proposed Taxiway N*
Lat/Long: *61.592447/-149.09217*
Elevation:

Equipment Type: *CME 75*
Field Crew: *Discovery Drilling*
Geologist: *J. LaBelle*

Total Depth: *12.0 feet*
Date: *11/3/2021*

Ground Water Data		
Depth (feet)		
Time		
Date		
Symbol		

Depth (Feet)	Drilling Method	Sample Data: Sample Type	Sample Data: Number	Sample Data: Blow Count	Sample Data: Sample	Sample Data: Recovery	Sample Data: N-Value	USCS Classification Bonded Zone	Soil Graphic	SUBSURFACE MATERIAL	
0	Hollow-Stem Auger									ORGANIC MAT	0.0
1		MSS	S-1	1 2 2 3			4	ml		SILT, (ml); some sand, fine; trace organics; brown, dry Moisture =26.9%	0.7
2											
3		MSS	S-2	1 1 2 3			3			very loose, F4 P200 =72.9%, Sa =26.7%, Gr =0.4%, Moisture =26.4%, Org =3.6%	2.5
4											
5				6							
6		MSS	S-3	12 15 25			27	gw-gm		Well-graded GRAVEL, (gw-gm); fine to coarse; angular to subrounded, with sand, fine to coarse; little silt; gray, dry Moisture =2.2%	5.6
7											
8		MSS	S-4	17 29 25 28			54			very dense, broken cobble in sample Moisture =1.8%	7.5
9											
10				14						dense, F1 P200 =6.5%, Sa =38.2%, Gr =55.3%, Moisture =1.6%	10.0
11		MSS	S-5	15 31 28			46				
12									BOH 12	Notes: No free groundwater encountered.	12.0

☒ Auto Hammer ☐ Cathead Rope Method ☐ 140 lb. hammer with 30 in. drop ☒ 340 lb. hammer with 30 in. drop

HDL ENGINEERING Consultants LLC

LOG OF BORING

Hole #:**HDL-18**

PROJECT NUMBER : *18-001-15*
PROJECT : *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Station / Location: *near proposed Taxiway N*
Lat/Long: *61.592256/-149.091097*
Elevation:

Equipment Type: *CME 75*
Field Crew: *Discovery Drilling*
Geologist: *J. LaBelle*

Total Depth: *8.1 feet*
Date: *11/3/2021*

Ground Water Data		
Depth (feet)		
Time		
Date		
Symbol		

Depth (Feet)	Drilling Method	Sample Data: Sample Type	Sample Data: Number	Sample Data: Blow Count	Sample Data: Sample	Sample Data: Recovery	Sample Data: N-Value	USCS Classification Bonded Zone	Soil Graphic	SUBSURFACE MATERIAL
0	Hollow-Stem Auger	MSS	S-1	1						ORGANIC MAT — 0.0
0.4				1				ml		SILT, (ml); little sand, fine; trace to little organics; light brown to brown, dry, loose — 0.4
1				1			6			Moisture =25.6%
2				5						
2.8				2						very loose, F4 — 2.8
3		MSS	S-2	3			3			P200 =86.0%, Sa =13.4%, Gr =0.6%, Moisture =8.5%
4				1						
5				2						
				3						
5.0				4				sm		SAND, (sm); fine; with silt; trace gravel, fine; light brown, dry, loose — 5.0
6		MSS	S-3	5			10			Moisture =8.1%
				5						
7				28						
		MSS	S-4	50						refusal 50/2", Moisture =7.2%
8									BOH 8.1	8.1

Notes:
No free groundwater encountered. Hole terminated due to broken spoon stuck down the hole.

☒ Auto Hammer ☐ Cathead Rope Method ☐ 140 lb. hammer with 30 in. drop ☒ 340 lb. hammer with 30 in. drop

HDL ENGINEERING Consultants LLC

LOG OF BORING

Hole #:**HDL-19**

PROJECT NUMBER : *18-001-15*
PROJECT : *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Station / Location: *near proposed Taxiway N*
Lat/Long: *61.593343/-149.094733*
Elevation:

Equipment Type: *CME 75*
Field Crew: *Discovery Drilling*
Geologist: *J. LaBelle*

Total Depth: *11.8 feet*
Date: *11/3/2021*

Ground Water Data		
Depth (feet)		
Time		
Date		
Symbol		

Depth (Feet)	Drilling Method	Sample Data: Sample Type	Sample Data: Number	Sample Data: Blow Count	Sample Data: Sample	Sample Data: Recovery	Sample Data: N-Value	USCS Classification Bonded Zone	Soil Graphic	SUBSURFACE MATERIAL
0	Hollow-Stem Auger	MSS	S-1	1						ORGANIC MAT — 0.0
0.5				1				ml		SILT, (ml); some sand, fine; trace organics; brown, dry, very loose — 0.5
1				1			3			Moisture =33.6%
2				2						
2.5				3						F4 — 2.5
3		MSS	S-2	1						P200 =83.4%, Sa =16.6%, Gr =0.0%, Moisture =35.3%, Org =4.8%
4				2			4			
5				2						
6		MSS	S-3	3						
				2						
				4						
				8			12	sp-sm		Poorly-graded SAND, (sp-sm); fine to coarse; some to with gravel, fine to course; subangular to subrounded; little silt; brown, dry — 6.0
7				23						Moisture =2.5%
7.5										dense, broken cobble in sample — 7.5
8		MSS	S-4	6						Moisture =3.0%
				15						
				22			37			
9				25						
10				7						very dense — 10.0
		MSS	S-5	27						refusal 50/4", Moisture =1.9%
11				50			77			
11.8									BOH 11.8	Notes: — 11.8
										No free groundwater encountered.

☒ Auto Hammer ☐ Cathead Rope Method ☐ 140 lb. hammer with 30 in. drop ☒ 340 lb. hammer with 30 in. drop

HDL ENGINEERING Consultants LLC

LOG OF BORING

Hole #:**HDL-20**

PROJECT NUMBER : *18-001-15*
PROJECT : *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Station / Location: *near proposed access road*
Lat/Long: *61.593825/-149.101377*
Elevation:

Equipment Type: *CME 75*
Field Crew: *Discovery Drilling*
Geologist: *J. LaBelle*

Total Depth: *6.0 feet*
Date: *11/4/2021*

Depth (Feet)	Drilling Method	Sample Data: Sample Type	Sample Data: Number	Sample Data: Blow Count	Sample Data: Sample	Sample Data: Recovery	Sample Data: N-Value	USCS Classification Bonded Zone	Soil Graphic	SUBSURFACE MATERIAL
0	Continuous MPT Sampling	MSS	S-1	6				gw-gm		Well-graded GRAVEL, (gw-gm); fine to coarse; subangular to subrounded, with sand, fine to coarse; little silt; gray, dry, medium dense, F1 P200 =6.8%, Sa =38.1%, Gr =55.1%, Moisture =3.4%
1				7			15			
				8						
2				5						
				4						
2.6										
3		MSS	S-2	2				ml		SILT, (ml); little sand, fine; little organics; brown, dry to moist, F4 P200 =90.6%, Sa =8.8%, Gr =0.6%, Moisture =36.7%, Org =5.3%
				2			4			
				2						
4				1						medium dense, broken cobble in sample Moisture =20.6%
4.0										
5		MSS	S-3	5						
				10			15			
				11						
6									BOH 6	
6.0										Notes: No free groundwater encountered.

Ground Water Data		
Depth (feet)		
Time		
Date		
Symbol		

☒ Auto Hammer ☐ Cathead Rope Method ☐ 140 lb. hammer with 30 in. drop ☒ 340 lb. hammer with 30 in. drop

HDL ENGINEERING Consultants LLC

LOG OF BORING

Hole #:**HDL-21**

PROJECT NUMBER : *18-001-15*
PROJECT : *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Station / Location: *near proposed access road*
Lat/Long: *61.593107/-149.101579*
Elevation:

Equipment Type: *CME 75*
Field Crew: *Discovery Drilling*
Geologist: *J. LaBelle*

Total Depth: *7.0 feet*
Date: *11/4/2021*

Ground Water Data		
Depth (feet)		
Time		
Date		
Symbol		

Depth (Feet)	Drilling Method	Sample Data: Sample Type	Sample Data: Number	Sample Data: Blow Count	Sample Data: Sample	Sample Data: Recovery	Sample Data: N-Value	USCS Classification Bonded Zone	Soil Graphic	SUBSURFACE MATERIAL	
0	Hollow-Stem Auger	MSS	S-1	13			13	ml		SILT, (ml); with sand, fine to coarse; some gravel, fine to coarse; subrounded; brown, dry, medium dense	0.0
1				8							
				5							
2				3							
										F4	2.5
3		MSS	S-2	5						P200 =45.3%, Sa =38.0%, Gr =16.7%, Moisture =16.5%	
				8							
4				18			26				3.8
				24				sp-sm		Poorly-graded SAND, (sp-sm); fine to coarse; with gravel, fine to coarse; subangular to subrounded; little silt; brown, dry, broken cobble in sample Moisture =2.8%	
5										dense Moisture =2.4%	5.0
				13							
6		MSS	S-3	23			40				
				17							
7				17					BOH 7		7.0

Notes:
No free groundwater encountered.

☒ Auto Hammer ☐ Cathead Rope Method ☐ 140 lb. hammer with 30 in. drop ☒ 340 lb. hammer with 30 in. drop

Sheet Number 1 of 1

A USCS LOG OF TEST HOLE 18-001-15 PALMER TW N APRON E.GPJ HDL MODIFIED.GDT 7/19/22

HDL ENGINEERING Consultants LLC

LOG OF TEST PIT

TEST PIT # HDL-22

PROJECT NUMBER: *18-001-15*
PROJECT: *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Ground Water Data		
Depth in (ft.)		
Time		
Date		
Symbol		

Geologist: *J. LaBelle*
Field Crew: *City of Palmer Public Works*
Equipment Type: *John Deere 410E*
Location: *near proposed infiltration basin*
Lat/Long: *61.587234/-149.086063*

Total Depth: *12.0 feet*
Date: *11/5/2021*

Depth (Feet)	Sample Type	Field Number	Sample	USCS Classification Frozen Zone	Soil Graphic	SUBSURFACE MATERIAL
0						ORGANIC MAT — 0.0
1				ml		SILT, (ml); with sand, fine; trace organics; brownish gray, dry — 0.8
2						
3	GRAB	S-1				Moisture =20.9%
4						
5						
6						
7						
8						
9	GRAB	S-2		GW		Well-graded GRAVEL, (GW); fine to coarse; subangular to subrounded, with sand, fine to coarse; trace silt; gray, dry NFS — 9.0
10						P200 =1.0%, Sa =32.1%, Gr =66.9%, Moisture =1.5%
11						
12					BOH 12	Notes: No free groundwater encountered. — 12.0

B USCS LOG OF TEST PIT 18-001-15 PALMER TW N APRON E.GPJ HDL MODIFIED.GDT 7/19/22

HDL ENGINEERING Consultants LLC

LOG OF TEST PIT

TEST PIT # HDL-23

PROJECT NUMBER: *18-001-15*
PROJECT: *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Ground Water Data		
Depth in (ft.)		
Time		
Date		
Symbol		

Geologist: *J. LaBelle*
Field Crew: *City of Palmer Public Works*
Equipment Type: *John Deere 410E*
Location: *near proposed infiltration basin*
Lat/Long: *61.586474/-149.086371*

Total Depth: *9.5 feet*
Date: *11/5/2021*

Depth (Feet)	Sample Type	Field Number	Sample	USCS Classification Frozen Zone	Soil Graphic	SUBSURFACE MATERIAL	
0						ORGANIC MAT	0.0
1							
2				ml		SILT, (ml); with sand, fine; trace organics; brownish gray, dry	1.3
3							
4							
5	GRAB	S-1				Moisture =26.9%	
6							
7							
8							
9	GRAB	S-2		sp	BOH 9.5	Poorly-graded SAND, (sp); fine to coarse; with gravel, fine to course; subangular to subrounded; trace to little silt; gray, dry	9.0
						Moisture =3.2%	9.5

Notes:
No free groundwater encountered.

HDL ENGINEERING Consultants LLC

LOG OF TEST PIT

TEST PIT # HDL-24

PROJECT NUMBER: *18-001-15*
PROJECT: *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Ground Water Data		
Depth in (ft.)		
Time		
Date		
Symbol		

Geologist: *J. LaBelle*
Field Crew: *City of Palmer Public Works*
Equipment Type: *John Deere 410E*
Location: *near proposed infiltration basin*
Lat/Long: *61.585706/-149.085728*

Total Depth: *11.0 feet*
Date: *11/5/2021*

Depth (Feet)	Sample Data: Sample Type	Sample Data: Field Number	Sample Data: Sample	USCS Classification Frozen Zone	Soil Graphic	SUBSURFACE MATERIAL
0						ORGANIC MAT — 0.0
0.5				ml		SILT, (ml); with sand, fine; trace organics; brownish gray, dry
4	GRAB	S-1				Moisture =28.2%
7.5						— 7.5
8	GRAB	S-2		sp-sm		Poorly-graded SAND, (sp-sm); fine to coarse; with gravel, fine to coarse; subangular to subrounded; little silt; gray, dry Moisture =2.9%
11					BOH 11	Notes: No free groundwater encountered. — 11.0

B USCS LOG OF TEST PIT 18-001-15 PALMER TW N APRON E.GPJ HDL MODIFIED.GDT 7/19/22

HDL ENGINEERING Consultants LLC

LOG OF TEST PIT

TEST PIT # HDL-25

PROJECT NUMBER: *18-001-15*
PROJECT: *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Ground Water Data		
Depth in (ft.)		
Time		
Date		
Symbol		

Geologist: *J. LaBelle*
Field Crew: *City of Palmer Public Works*
Equipment Type: *John Deere 410E*
Location: *near proposed infiltration basin*
Lat/Long: *61.585503/-149.08603*

Total Depth: *2.0 feet*
Date: *11/5/2021*

Depth (Feet)	Sample Type	Field Number	Sample	USCS Classification Frozen Zone	Soil Graphic	SUBSURFACE MATERIAL	
0						ORGANIC MAT	0.0
1	GRAB	S-1		GP		Poorly-graded GRAVEL, (GP); fine to coarse; subangular to subrounded, with sand, fine to coarse; trace silt; gray, dry NFS	0.2
2					BOH 2	P200 =3.1%, Sa =44.4%, Gr =52.5%, Moisture =4.5%	2.0

Notes:
No free groundwater encountered.

B USCS LOG OF TEST PIT 18-001-15 PALMER TW N APRON E.GPJ HDL MODIFIED.GDT 7/19/22

HDL ENGINEERING Consultants LLC

LOG OF BORING

Hole #:**HDL-26**

PROJECT NUMBER : *18-001-15*
PROJECT : *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Station / Location: *near proposed Apron E*
Lat/Long: *61.59623/-149.10251*
Elevation:

Equipment Type: *CME 75*
Field Crew: *Discovery Drilling*
Geologist: *J. LaBelle*

Total Depth: *9.0 feet*
Date: *2/4/2022*

Ground Water Data		
Depth (feet)		
Time		
Date		
Symbol		

Depth (Feet)	Drilling Method	Sample Data: Sample Type	Sample Data: Number	Sample Data: Blow Count	Sample Data: Sample	Sample Data: Recovery	Sample Data: N-Value	USCS Classification	Bonded Zone	Soil Graphic	SUBSURFACE MATERIAL
0	Hollow-Stem Auger	GRAB	S-1					ml			SILT, (ml); with sand, fine; trace organics; brown, moist, Nbn Moisture =22.6%
2.5		MSS	S-2	5 3 5			8				brown gray mottling, dry, loose Moisture =29.2%
5.0		MSS	S-3	3 3 8			11				brown, medium dense Moisture =26.8%
7.5		MSS	S-4	11 12 11			23	sp-sm			Poorly-graded SAND, (sp-sm); fine to coarse; with gravel, fine to coarse; subrounded to subangular; little silt; gray, dry, medium dense Moisture =3.3%
9.0										BOH 9	Notes: No free groundwater encountered.

☒ Auto Hammer ☐ Cathead Rope Method ☐ 140 lb. hammer with 30 in. drop ☒ 340 lb. hammer with 30 in. drop

Sheet Number 1 of 1

A USCS LOG OF TEST HOLE 18-001-15 PALMER TW N APRON E.GPJ HDL MODIFIED.GDT 7/19/22

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LOG OF BORING

Hole #:**HDL-27**

PROJECT NUMBER : *18-001-15*
PROJECT : *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Station / Location: *near proposed Apron E*
Lat/Long: *61.59628/-149.10156*
Elevation:

Equipment Type: *CME 75*
Field Crew: *Discovery Drilling*
Geologist: *J. LaBelle*

Total Depth: *9.0 feet*
Date: *2/4/2022*

Ground Water Data		
Depth (feet)		
Time		
Date		
Symbol		

Depth (Feet)	Drilling Method	Sample Data: Sample Type	Sample Data: Number	Sample Data: Blow Count	Sample Data: Sample	Sample Data: Recovery	Sample Data: N-Value	USCS Classification Bonded Zone	Soil Graphic	SUBSURFACE MATERIAL
0	Hollow-Stem Auger	GRAB	S-1					sm		SAND, (sm); fine to coarse; some gravel, fine; little silt; brown, dry, F2 P200 =14.7%, Sa =59.8%, Gr =25.5%, Moisture =7.4%
2.5		MSS	S-2	2 2 1			3	ml		SILT, (ml); with sand, fine; trace organics; brown gray mottling, dry, very loose Moisture =31.9%
5.0		MSS	S-3	1 4 7			11			brown, medium dense Moisture =23.2%
7.5		MSS	S-4	17 19 25			44	sp-sm		Poorly-graded SAND, (sp-sm); fine to coarse; with gravel, fine to coarse; little silt; gray, dry, dense Moisture =4.0%
9.0									BOH 9	Notes: No free groundwater encountered.

☒ Auto Hammer ☐ Cathead Rope Method ☐ 140 lb. hammer with 30 in. drop ☒ 340 lb. hammer with 30 in. drop

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LOG OF BORING

Hole #:**HDL-28**

PROJECT NUMBER : *18-001-15*
PROJECT : *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Station / Location: *near proposed Apron E*
Lat/Long: *61.59639/-149.10101*
Elevation:

Equipment Type: *CME 75*
Field Crew: *Discovery Drilling*
Geologist: *J. LaBelle*

Total Depth: *11.5 feet*
Date: *2/4/2022*

Ground Water Data		
Depth (feet)		
Time		
Date		
Symbol		

Depth (Feet)	Drilling Method	Sample Data: Sample Type	Sample Data: Number	Sample Data: Blow Count	Sample Data: Sample	Sample Data: Recovery	Sample Data: N-Value	USCS Classification Bonded Zone	Soil Graphic	SUBSURFACE MATERIAL
0	Hollow-Stem Auger	GRAB	S-1					sm		SAND, (sm); fine to coarse; some gravel, fine to coarse; subrounded to subangular; some silt; brown, dry, F3, difficult drilling action P200 =17.5%, Sa =54.6%, Gr =27.9%, Moisture =6.2%
2.5										GRAVEL, (gm); fine to coarse; subrounded to subangular, with sand, fine to coarse; some silt; brown, moist Moisture =10.3%
3.3		MSS	S-2	4 3 2			5	gm ml		SILT, (ml); with sand, fine; trace organics; brown gray mottling, dry Moisture =33.0%
5.0		MSS	S-3	2 1 2			3			very loose Moisture =34.8%
7.5		MSS	S-4	14				gp-gm		Poorly-graded GRAVEL, (gp-gm); fine to coarse; subrounded to subangular, with sand, fine to coarse; little silt; gray, dry Refusal 30/2", Moisture =3.8%
10.0		MSS	S-5	17 13 17			30			medium dense Moisture =3.8%
11.5									BOH 11.5	Notes: No free groundwater encountered.

☒ Auto Hammer ☐ Cathead Rope Method ☐ 140 lb. hammer with 30 in. drop ☒ 340 lb. hammer with 30 in. drop

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LOG OF BORING

Hole #:**HDL-29**

PROJECT NUMBER : *18-001-15*
PROJECT : *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Station / Location: *near proposed Apron E*
Lat/Long: *61.59625/-149.10139*
Elevation:

Equipment Type: *CME 75*
Field Crew: *Discovery Drilling*
Geologist: *J. LaBelle*

Total Depth: *9.0 feet*
Date: *2/4/2022*

Ground Water Data		
Depth (feet)		
Time		
Date		
Symbol		

Depth (Feet)	Drilling Method	Sample Data: Sample Type	Sample Data: Number	Sample Data: Blow Count	Sample Data: Sample	Sample Data: Recovery	Sample Data: N-Value	USCS Classification Bonded Zone	Soil Graphic	SUBSURFACE MATERIAL
0	Hollow-Stem Auger	GRAB	S-1					sm		SAND, (sm); fine to coarse; with gravel, fine; subrounded to subangular; some silt; brown, moist, F3 P200 =27.5%, Sa =42.5%, Gr =30.0%, Moisture =17.8%
2.5										
3		MSS	S-2	5 3 4			7	ml		SILT, (ml); with sand, fine; trace gravel, fine; trace organics; brown, dry, loose Moisture =27.0%
5.9										
6		MSS	S-3	8 10 12			22	GP		Poorly-graded GRAVEL, (GP); fine to coarse; subrounded to subangular, some sand, fine to coarse; trace silt; gray, dry, NFS, fractured cobbles in sample P200 =4.1%, Sa =24.6%, Gr =71.3%, Moisture =3.2%
7.5										
8		MSS	S-4	8 14 12			26	sp-sm		Poorly-graded SAND, (sp-sm); fine to coarse; with gravel, fine to coarse; subrounded to subangular; little silt; gray, dry, medium dense Moisture =3.8%
9									BOH 9	Notes: No free groundwater encountered.
9.0										

☒ Auto Hammer ☐ Cathead Rope Method ☐ 140 lb. hammer with 30 in. drop ☒ 340 lb. hammer with 30 in. drop

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LOG OF BORING

Hole #:**HDL-30**

PROJECT NUMBER : *18-001-15*
PROJECT : *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Station / Location: *near proposed Apron E*
Lat/Long: *61.59608/-149.10049*
Elevation:

Equipment Type: *CME 75*
Field Crew: *Discovery Drilling*
Geologist: *J. LaBelle*

Total Depth: *9.0 feet*
Date: *2/4/2022*

Ground Water Data		
Depth (feet)		
Time		
Date		
Symbol		

Depth (Feet)	Drilling Method	Sample Data: Sample Type	Sample Data: Number	Sample Data: Blow Count	Sample Data: Sample	Sample Data: Recovery	Sample Data: N-Value	USCS Classification Bonded Zone	Soil Graphic	SUBSURFACE MATERIAL
0	Hollow-Stem Auger	GRAB	S-1					sm		SAND, (sm); fine to coarse; some gravel, fine to coarse; subrounded to subangular; some silt; brown, dry, F3 P200 =21.0%, Sa =58.8%, Gr =20.2%, Moisture =4.0%
2.5										SILT, (ml); with sand, fine; trace organics; brown gray mottling, dry, very loose Moisture =34.5%
3		MSS	S-2	3 2 2			4	ml		
5.6										Poorly-graded SAND, (sp-sm); fine to coarse; little to some gravel, fine to coarse; subronded to subangular; trace to little silt; gray, dry Moisture =6.7%
5		MSS	S-3	5 8 11			19	sp-sm		
7.5										Poorly-graded GRAVEL, (gp-gm); fine to coarse; subrounded to subangular, with sand, fine to coarse; little silt; gray, dry, dense Moisture =3.1%
8		MSS	S-4	28 13 22			35	gp-gm		
9.0									BOH 9	Notes: No free groundwater encountered.

☒ Auto Hammer ☐ Cathead Rope Method ☐ 140 lb. hammer with 30 in. drop ☒ 340 lb. hammer with 30 in. drop

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LOG OF BORING

Hole #:**HDL-31**

PROJECT NUMBER : *18-001-15*
PROJECT : *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Station / Location: *near proposed Apron E*
Lat/Long: *61.59593/-149.09982*
Elevation:

Equipment Type: *CME 75*
Field Crew: *Discovery Drilling*
Geologist: *J. LaBelle*

Total Depth: *16.5 feet*
Date: *2/4/2022*

Ground Water Data		
Depth (feet)		
Time		
Date		
Symbol		

Depth (Feet)	Drilling Method	Sample Data: Sample Type	Sample Data: Number	Sample Data: Blow Count	Sample Data: Sample	Sample Data: Recovery	Sample Data: N-Value	USCS Classification	Bonded Zone	Soil Graphic	SUBSURFACE MATERIAL
0	Hollow-Stem Auger	GRAB	S-1					sm			Poorly-graded SAND, (sm); fine to coarse; some gravel, fine; subrounded; some silt; gray, dry, F3, Nf P200 =18.9%, Sa =61.7%, Gr =19.4%, Moisture =6.9%
2.5		MSS	S-2	10 19 26			45	sm sp-sm			SAND, (sm); fine; with silt; trace gravel, fine; brown, dry, Nbn Refusal 50/5", Moisture =24.7% Poorly-graded SAND, (sp-sm); fine to coarse; some gravel, fine to coarse; subrounded to angular; little silt; brown, dry, Nbn Moisture =4.7%
5.0		MSS	S-3	12 21 22			43				dense Moisture =2.5%
7.5		MSS	S-4	20 8 16			24	gp			Poorly-graded GRAVEL, (gp); fine to coarse; subangular to angular, with sand, fine to coarse; trace silt; gray, dry, medium dense, broken cobbles in sample Moisture =2.2%
10.0		MSS	S-5	16 24 15			39				dense Moisture =2.9%
12.5		MSS	S-6	17 29 28			57	gp-gm			Poorly-graded GRAVEL, (gp-gm); fine to coarse; subangular to angular, with sand, fine to coarse; little to some silt; gray, moist, very dense, difficult drilling action Moisture =4.3%
		MSS	S-7	30 31 20			51				Moisture =3.1%
16.5										BOH 16.5	Notes: No free groundwater encountered.

☒ Auto Hammer ☐ Cathead Rope Method ☐ 140 lb. hammer with 30 in. drop ☒ 340 lb. hammer with 30 in. drop

Sheet Number 1 of 1

A USCS LOG OF TEST HOLE 18-001-15 PALMER TW N APRON E.GPJ HDL MODIFIED.GDT 7/19/22

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LOG OF BORING

Hole #:**HDL-32**

PROJECT NUMBER : *18-001-15*
PROJECT : *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Station / Location: *near proposed Apron E*
Lat/Long: *61.59606/-149.09930*
Elevation:

Equipment Type: *CME 75*
Field Crew: *Discovery Drilling*
Geologist: *J. LaBelle*

Total Depth: *11.5 feet*
Date: *2/4/2022*

Ground Water Data		
Depth (feet)		
Time		
Date		
Symbol		

Depth (Feet)	Drilling Method	Sample Data: Sample Type	Sample Data: Number	Sample Data: Blow Count	Sample Data: Sample	Sample Data: Recovery	Sample Data: N-Value	USCS Classification Bonded Zone	Soil Graphic	SUBSURFACE MATERIAL
0	Hollow-Stem Auger	GRAB	S-1					ml		SILT, (ml); with sand, fine to coarse; trace gravel, fine; brown, moist, Nbn Moisture =36.9%
1										
2										
3		MSS	S-2	10 30 44			74	gw-gm		Moisture =28.9% **0.0** Well-graded GRAVEL, (gw-gm); fine to coarse; subrounded to subangular, with sand, fine to coarse; little silt; light brown, dry, F2 P200 =10.7%, Sa =38.7%, Gr =50.6%, Moisture =3.4% **3.3**
4										
5		MSS	S-3	22 17 17			34			brown, dense, broken cobbles in sample Moisture =2.5% **5.0**
6										
7										
8		MSS	S-4	41 10 9			19	sp-sm		Poorly-graded SAND, (sp-sm); fine to coarse; with gravel, fine to coarse; subrounded to subangular; little silt; gray, dry, medium dense Moisture =2.3% **7.5**
9										
10		MSS	S-5							rock in shoe; no recovery Refusal 50/3" **10.0**
11									BOH 11.5	**11.5** Notes: No free groundwater encountered.

☒ Auto Hammer ☐ Cathead Rope Method ☐ 140 lb. hammer with 30 in. drop ☒ 340 lb. hammer with 30 in. drop

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LOG OF BORING

Hole #:**HDL-33**

PROJECT NUMBER : *18-001-15*
PROJECT : *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Station / Location: *near proposed Apron E*
Lat/Long: *61.59595/-149.10089*
Elevation:

Equipment Type: *CME 75*
Field Crew: *Discovery Drilling*
Geologist: *J. LaBelle*

Total Depth: *9.0 feet*
Date: *2/4/2022*

Ground Water Data		
Depth (feet)		
Time		
Date		
Symbol		

Depth (Feet)	Drilling Method	Sample Type	Number	Blow Count	Sample	Recovery	N-Value	USCS Classification Bonded Zone	Soil Graphic	SUBSURFACE MATERIAL
0	Hollow-Stem Auger	GRAB	S-1					sm		SAND, (sm); fine to coarse; some gravel, fine; some silt; brown, dry, F3 P200 =20.3%, Sa =53.6%, Gr =26.1%, Moisture =10.3%
0.0										
2.5										
3		MSS	S-2	3 3 3			6	ml		SILT, (ml); with sand, fine; trace organics; brown, dry to moist, loose Moisture =40.0%
5.0										
5		MSS	S-3	2 1 2			3			brown gray mottling, very loose Moisture =32.9%
7.5										
8		MSS	S-4	13 15 21			36	gp-gm		Poorly-graded GRAVEL, (gp-gm); fine to coarse; subrounded to subangular, with sand, medium to coarse; little silt; gray, dry, dense Moisture =4.5%
9.0									BOH 9	Notes: No free groundwater encountered.

☒ Auto Hammer ☐ Cathead Rope Method ☐ 140 lb. hammer with 30 in. drop ☒ 340 lb. hammer with 30 in. drop

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LOG OF BORING

Hole #:**HDL-34**

PROJECT NUMBER : *18-001-15*
PROJECT : *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Station / Location: *near proposed Apron E*
Lat/Long: *61.59568/-149.10011*
Elevation:

Equipment Type: *CME 75*
Field Crew: *Discovery Drilling*
Geologist: *J. LaBelle*

Total Depth: *9.0 feet*
Date: *2/4/2022*

Ground Water Data		
Depth (feet)		
Time		
Date		
Symbol		

Depth (Feet)	Drilling Method	Sample Data: Sample Type	Sample Data: Number	Sample Data: Blow Count	Sample Data: Sample	Sample Data: Recovery	Sample Data: N-Value	USCS Classification Bonded Zone	Soil Graphic	SUBSURFACE MATERIAL
0	Hollow-Stem Auger	GRAB	S-1					sm		SAND, (sm); fine to coarse; some gravel, fine; subrounded to subangular; little to some silt; brown, moist Moisture =8.9% — 0.0
2.5		MSS	S-2	3 3 3			6	ml		SILT, (ml); with sand, fine; trace organics; brown, dry, loose Moisture =29.9%
5		MSS	S-3	1 2 4			6			Moisture =33.6% — 7.5
7.5		MSS	S-4	18 15 13			28	sp-sm		Poorly-graded SAND, (sp-sm); fine to coarse; with gravel, fine to coarse; subrounded to subangular; little silt; brown, dry, medium dense Moisture =3.9% — 9.0
9									BOH 9	Notes: No free groundwater encountered.

☒ Auto Hammer ☐ Cathead Rope Method ☐ 140 lb. hammer with 30 in. drop ☒ 340 lb. hammer with 30 in. drop

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LOG OF BORING

Hole #:**HDL-35**

PROJECT NUMBER : *18-001-15*
PROJECT : *Construct Taxiway N & Improve Airport Drainage*
CLIENT : *City of Palmer*

Station / Location: *near proposed Apron E*
Lat/Long: *61.59574/-149.09952*
Elevation:

Equipment Type: *CME 75*
Field Crew: *Discovery Drilling*
Geologist: *J. LaBelle*

Total Depth: *12.0 feet*
Date: *2/4/2022*

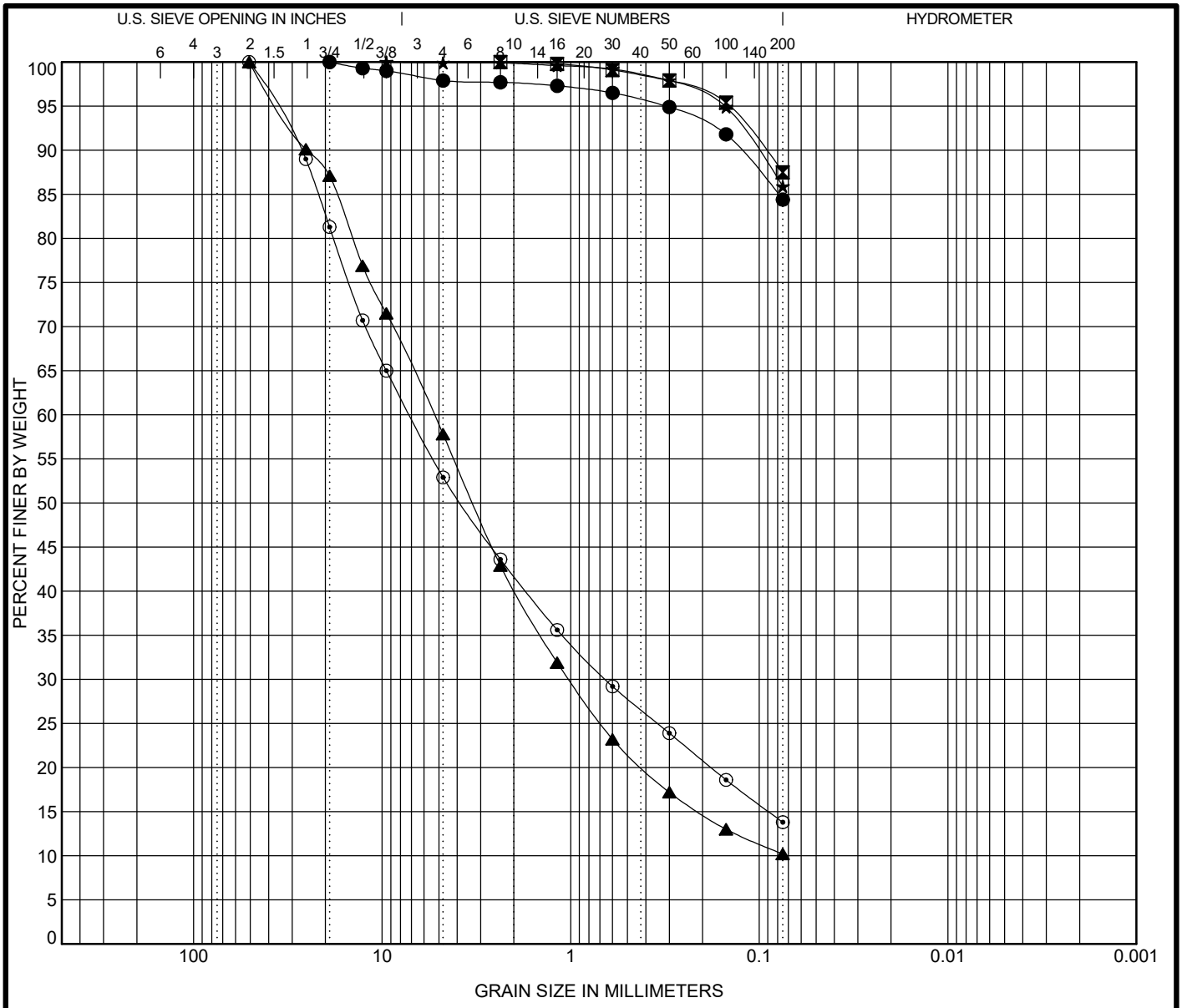
Ground Water Data		
Depth (feet)		
Time		
Date		
Symbol		

Depth (Feet)	Drilling Method	Sample Data: Sample Type	Sample Data: Number	Sample Data: Blow Count	Sample Data: Sample	Sample Data: Recovery	Sample Data: N-Value	USCS Classification Bonded Zone	Soil Graphic	SUBSURFACE MATERIAL
0	Hollow-Stem Auger	GRAB	S-1					sm		SAND, (sm); fine to coarse; with gravel, fine to coarse; subrounded to subangular; little silt; gray, dry, F2 P200 =14.3%, Sa =54.9%, Gr =30.8%, Moisture =6.6%
0.0										
2.5		MSS	S-2	16 29						broken cobbles in sample Refusal 50/5", Moisture =3.9%
5		MSS	S-3							Refusal 50/4", Moisture =5.1%
7.5		MSS	S-4	25 12 13 39			25			medium dense Moisture =2.2%
10.0		MSS	S-5	21 20 23 19			43			dense Moisture =3.5%
12.0									BOH 12	Notes: No free groundwater encountered.

☒ Auto Hammer ☐ Cathead Rope Method ☐ 140 lb. hammer with 30 in. drop ☒ 340 lb. hammer with 30 in. drop

Appendix E

Laboratory Test Results



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	**HDL-01 DEPTH 2.5**						
⊠	**HDL-02 DEPTH 2.5**						
▲	**HDL-02 DEPTH 7.5**					**2.73**	**74.38**
★	**HDL-03 DEPTH 2.5**						
⊙	**HDL-03 DEPTH 5.4**						

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**HDL-01 DEPTH 2.5**	**19**				**2.1**	**13.5**	**84.4**	
⊠	**HDL-02 DEPTH 2.5**	**2.36**				**0.0**	**12.5**	**87.5**	
▲	**HDL-02 DEPTH 7.5**	**50.8**	**5.309**	**1.018**		**42.2**	**47.6**	**10.2**	
★	**HDL-03 DEPTH 2.5**	**9.5**				**0.1**	**14.0**	**85.9**	
⊙	**HDL-03 DEPTH 5.4**	**50.8**	**7.134**	**0.653**		**47.1**	**39.1**	**13.8**	

HDL ENGINEERING Consultants LLC
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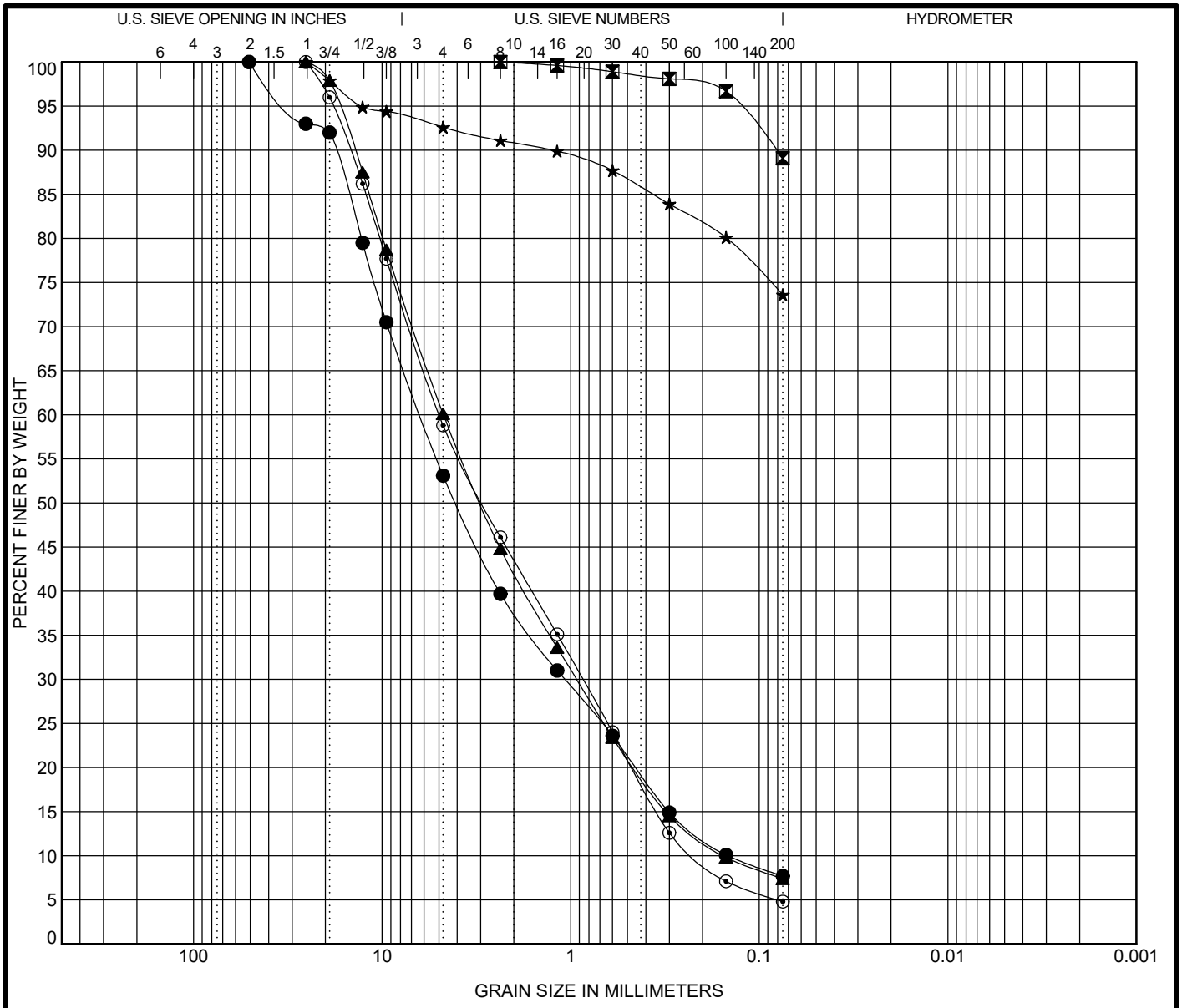
GRAIN SIZE DISTRIBUTION

Project: Construct Taxiway N & Improve Airport Drainage

Client: City of Palmer

Project Number: 18-001-15



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	**HDL-04 DEPTH 0.0**					**1.27**	**42.91**
⊠	**HDL-05 DEPTH 0.5**						
▲	**HDL-06 DEPTH 0.0**					**1.18**	**30.61**
★	**HDL-06 DEPTH 0.8**						
⊙	**HDL-07 DEPTH 0.0**	**POORLY GRADED SAND with GRAVEL(SP)**				**0.70**	**22.96**

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**HDL-04 DEPTH 0.0**	**50.8**	**6.253**	**1.077**	**0.146**	**46.9**	**45.4**	**7.7**	
⊠	**HDL-05 DEPTH 0.5**	**2.36**				**0.0**	**10.9**	**89.1**	
▲	**HDL-06 DEPTH 0.0**	**25.4**	**4.728**	**0.929**	**0.154**	**39.9**	**52.7**	**7.4**	
★	**HDL-06 DEPTH 0.8**	**25.4**				**7.4**	**19.0**	**73.6**	
⊙	**HDL-07 DEPTH 0.0**	**25.4**	**4.964**	**0.865**	**0.216**	**41.2**	**54.0**	**4.8**	

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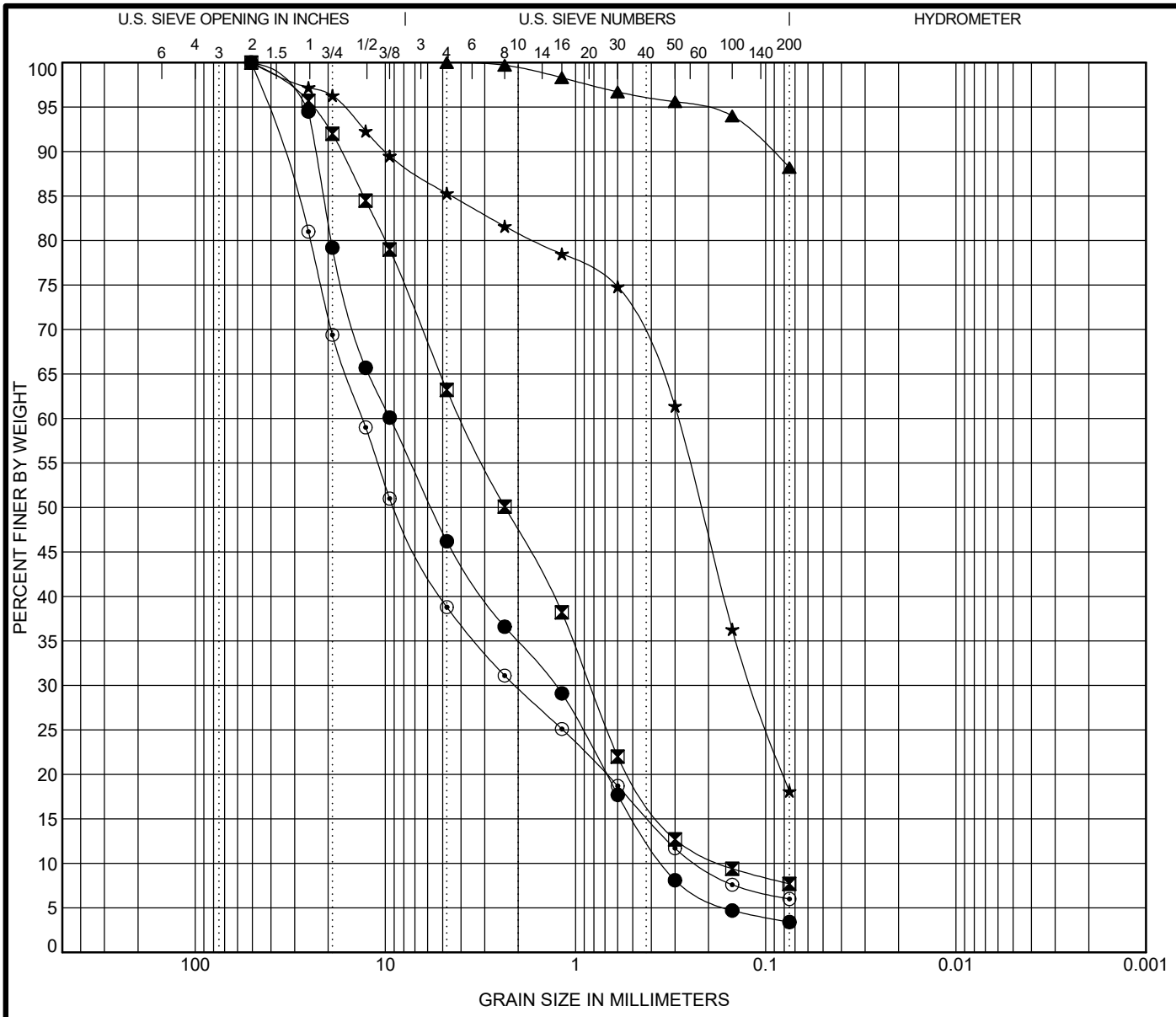
GRAIN SIZE DISTRIBUTION

Project: Construct Taxiway N & Improve Airport Drainage

Client: City of Palmer

Project Number: 18-001-15



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	**HDL-08 DEPTH 3.3**	**POORLY GRADED GRAVEL with SAND(GP)**				**0.51**	**27.47**
⊠	**HDL-08 DEPTH 10.0**					**1.03**	**23.53**
▲	**HDL-09 DEPTH 3.3**						
★	**HDL-09 DEPTH 5.7**						
⊙	**HDL-10 DEPTH 2.8**					**1.45**	**58.66**

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**HDL-08 DEPTH 3.3**	**50.8**	**9.453**	**1.282**	**0.344**	**53.8**	**42.8**	**3.4**	
⊠	**HDL-08 DEPTH 10.0**	**50.8**	**4.004**	**0.838**	**0.17**	**36.8**	**55.5**	**7.7**	
▲	**HDL-09 DEPTH 3.3**	**4.75**				**0.0**	**11.8**	**88.2**	
★	**HDL-09 DEPTH 5.7**	**50.8**	**0.289**	**0.118**		**14.7**	**67.2**	**18.1**	
⊙	**HDL-10 DEPTH 2.8**	**50.8**	**13.202**	**2.078**	**0.225**	**61.2**	**32.8**	**6.0**	

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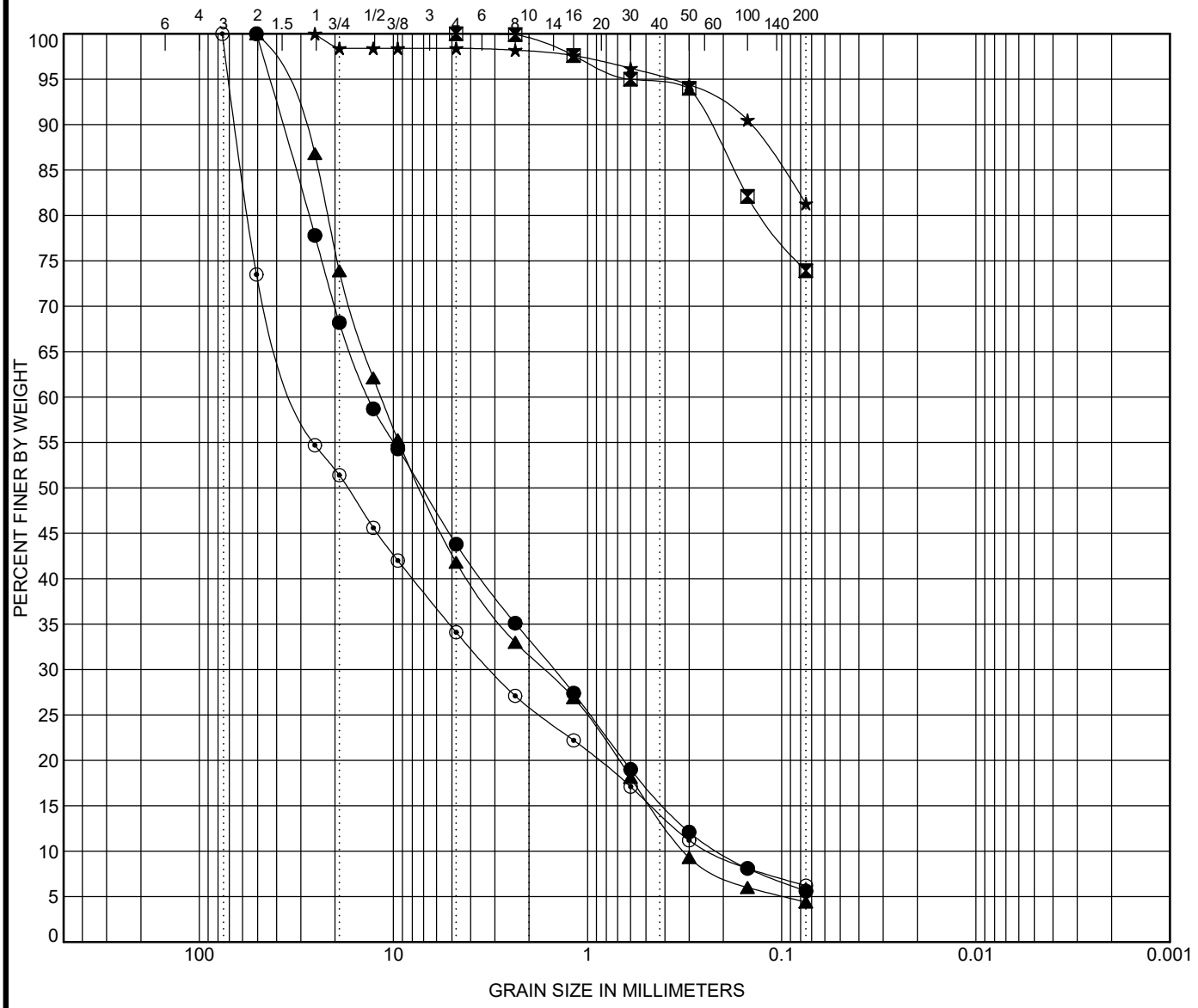
GRAIN SIZE DISTRIBUTION

Project: Construct Taxiway N & Improve Airport Drainage

Client: City of Palmer

Project Number: 18-001-15



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	LL	PL	PI	Cc	Cu
● **HDL-11 DEPTH 3.1**					**0.79**	**64.37**
⊠ **HDL-12 DEPTH 2.5**						
▲ **HDL-13 DEPTH 3.3**	**POORLY GRADED GRAVEL with SAND(GP)**				**0.77**	**36.63**
★ **HDL-14 DEPTH 2.5**						
⊙ **HDL-14 DEPTH 3.6**					**1.40**	**134.62**

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **HDL-11 DEPTH 3.1**	**50.8**	**13.42**	**1.491**	**0.208**	**56.2**	**38.2**	**5.6**	
⊠ **HDL-12 DEPTH 2.5**	**4.75**				**0.0**	**26.1**	**73.9**	
▲ **HDL-13 DEPTH 3.3**	**50.8**	**11.611**	**1.678**	**0.317**	**58.2**	**37.4**	**4.4**	
★ **HDL-14 DEPTH 2.5**	**25.4**				**1.6**	**17.1**	**81.3**	
⊙ **HDL-14 DEPTH 3.6**	**76.2**	**30.882**	**3.153**	**0.229**	**65.9**	**27.9**	**6.2**	

HDL ENGINEERING Consultants LLC
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Fax: 907-564-2122

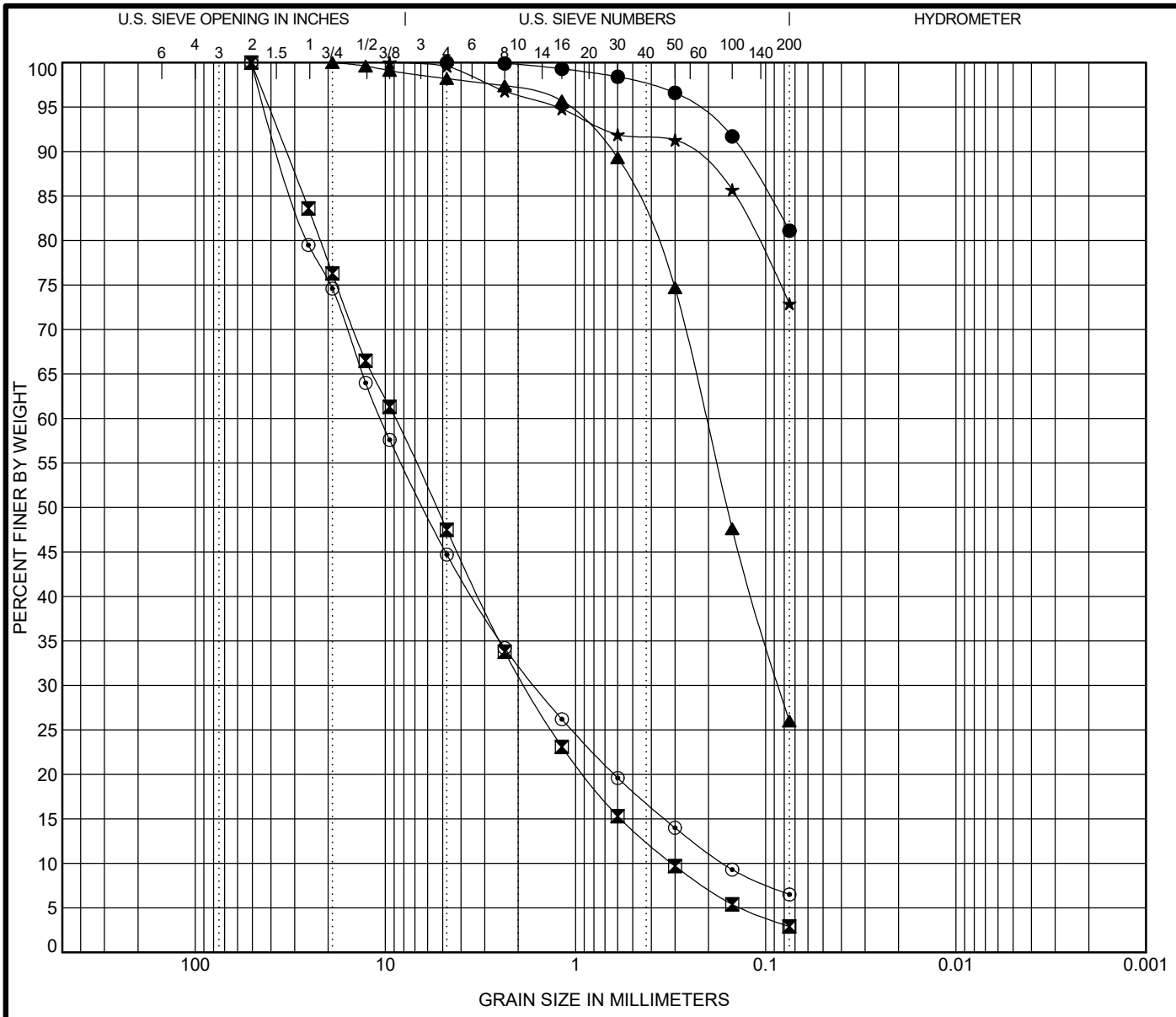
GRAIN SIZE DISTRIBUTION

Project: Construct Taxiway N & Improve Airport Drainage

Client: City of Palmer

Project Number: 18-001-15

US GRAIN SIZE 18-001-15 PALMER TW N APRON E.GPJ HDL MODIFIED.GDT 3/11/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	**HDL-15 DEPTH 2.5**						
⊠	**HDL-15 DEPTH 5.0**	**WELL-GRADED GRAVEL with SAND(GW)**				**1.23**	**28.58**
▲	**HDL-16 DEPTH 3.7**						
★	**HDL-17 DEPTH 2.5**						
⊙	**HDL-17 DEPTH 10.0**					**1.53**	**63.69**

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**HDL-15 DEPTH 2.5**	**4.75**				**0.0**	**18.9**	**81.1**	
⊠	**HDL-15 DEPTH 5.0**	**50.8**	**8.9**	**1.845**	**0.311**	**52.5**	**44.6**	**2.9**	
▲	**HDL-16 DEPTH 3.7**	**19**	**0.206**	**0.085**		**1.8**	**72.2**	**26.0**	
★	**HDL-17 DEPTH 2.5**	**9.5**				**0.4**	**26.7**	**72.9**	
⊙	**HDL-17 DEPTH 10.0**	**50.8**	**10.593**	**1.64**	**0.166**	**55.3**	**38.2**	**6.5**	

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Client: City of Palmer

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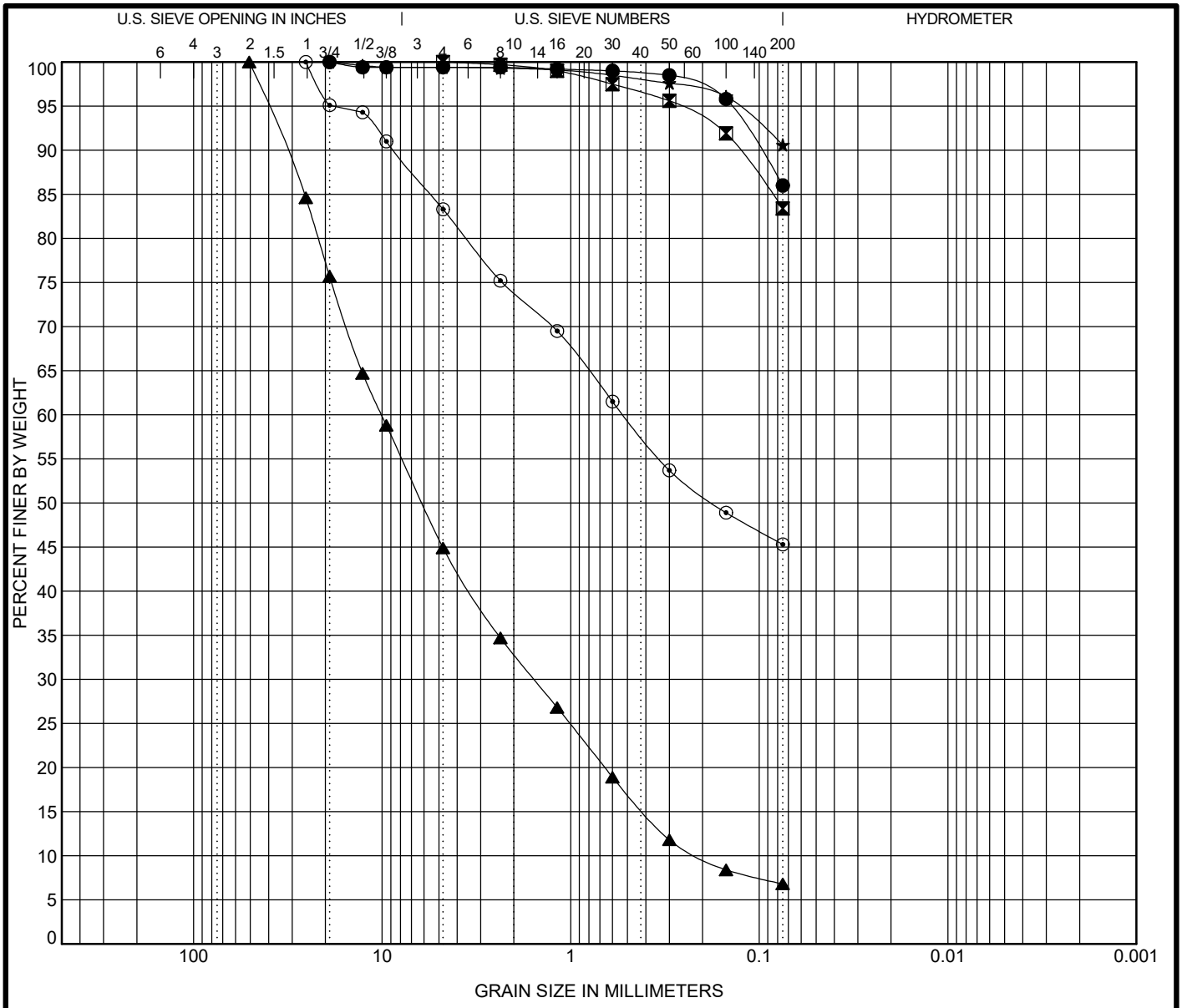
US GRAIN SIZE 18-001-15 PALMER TW N APRON E.GPJ HDL MODIFIED.GDT 3/11/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	LL	PL	PI	Cc	Cu
● HDL-18 DEPTH 2.8						
⊠ HDL-19 DEPTH 2.5						
▲ HDL-20 DEPTH 0.0					1.17	48.49
★ HDL-20 DEPTH 2.6						
⊙ HDL-21 DEPTH 2.5						

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● HDL-18 DEPTH 2.8	19				0.6	13.4	86.0	
⊠ HDL-19 DEPTH 2.5	4.75				0.0	16.6	83.4	
▲ HDL-20 DEPTH 0.0	50.8	10.078	1.562	0.208	55.1	38.1	6.8	
★ HDL-20 DEPTH 2.6	19				0.6	8.8	90.6	
⊙ HDL-21 DEPTH 2.5	25.4	0.525			16.7	38.0	45.3	

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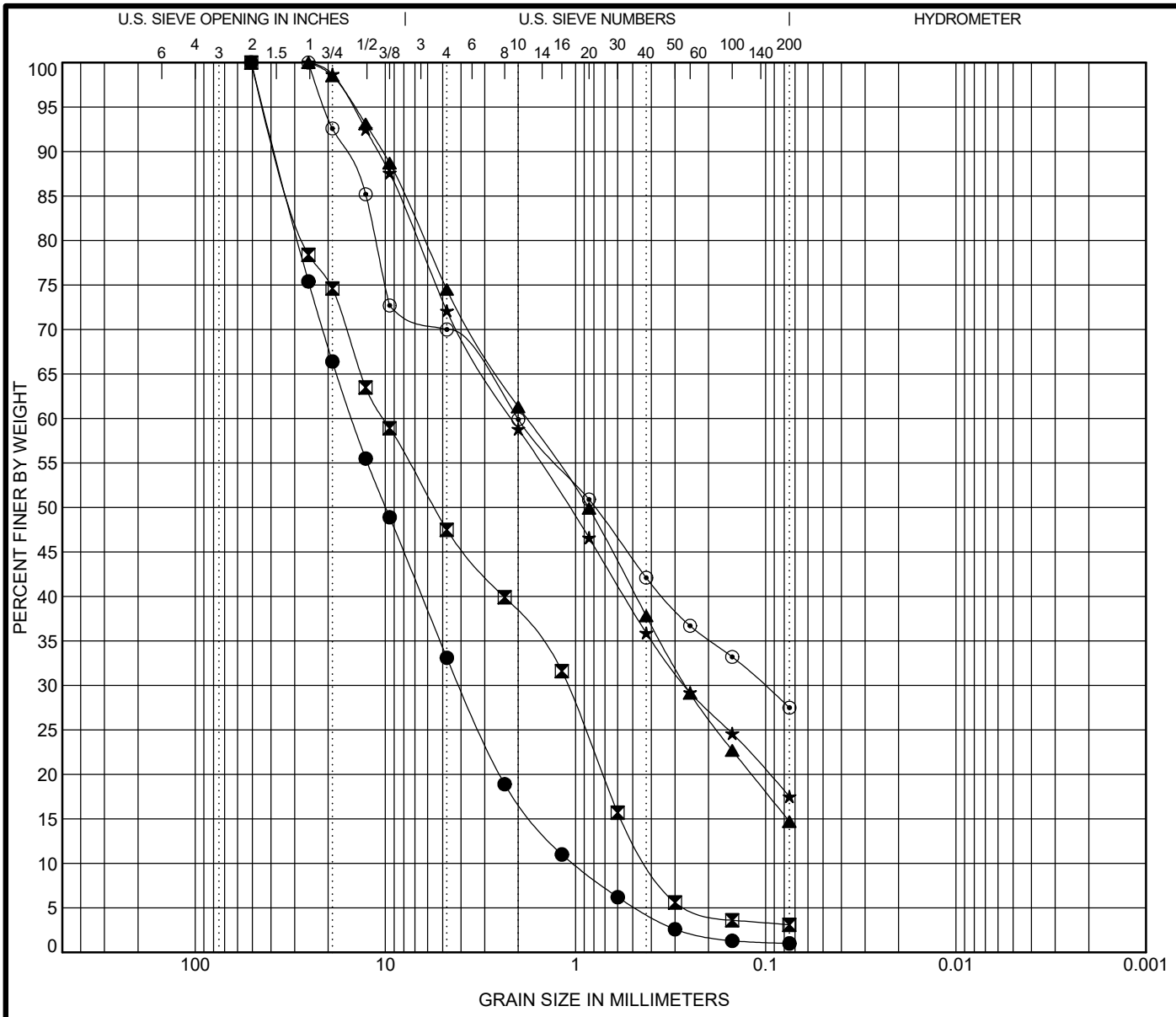
GRAIN SIZE DISTRIBUTION

Project: Construct Taxiway N & Improve Airport Drainage

Client: City of Palmer

Project Number: 18-001-15

US GRAIN SIZE 18-001-15 PALMER TW N APRON E.GPJ HDL MODIFIED.GDT 3/11/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	HDL-22	DEPTH 9.0	WELL-GRADED GRAVEL with SAND(GW)				1.08	14.63
⊠	HDL-25	DEPTH 0.2	POORLY GRADED GRAVEL with SAND(GP)				0.29	25.10
▲	HDL-27	DEPTH 0.0						
★	HDL-28	DEPTH 0.0						
⊙	HDL-29	DEPTH 0.0						

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	HDL-22	DEPTH 9.0	50.8	14.998	4.077	1.025	66.9	32.1	1.0	
⊠	HDL-25	DEPTH 0.2	50.8	10.183	1.102	0.406	52.5	44.4	3.1	
▲	HDL-27	DEPTH 0.0	25.4	1.814	0.264		25.5	59.8	14.7	
★	HDL-28	DEPTH 0.0	25.4	2.162	0.266		27.9	54.6	17.5	
⊙	HDL-29	DEPTH 0.0	25.4	2.017	0.102		30.0	42.5	27.5	

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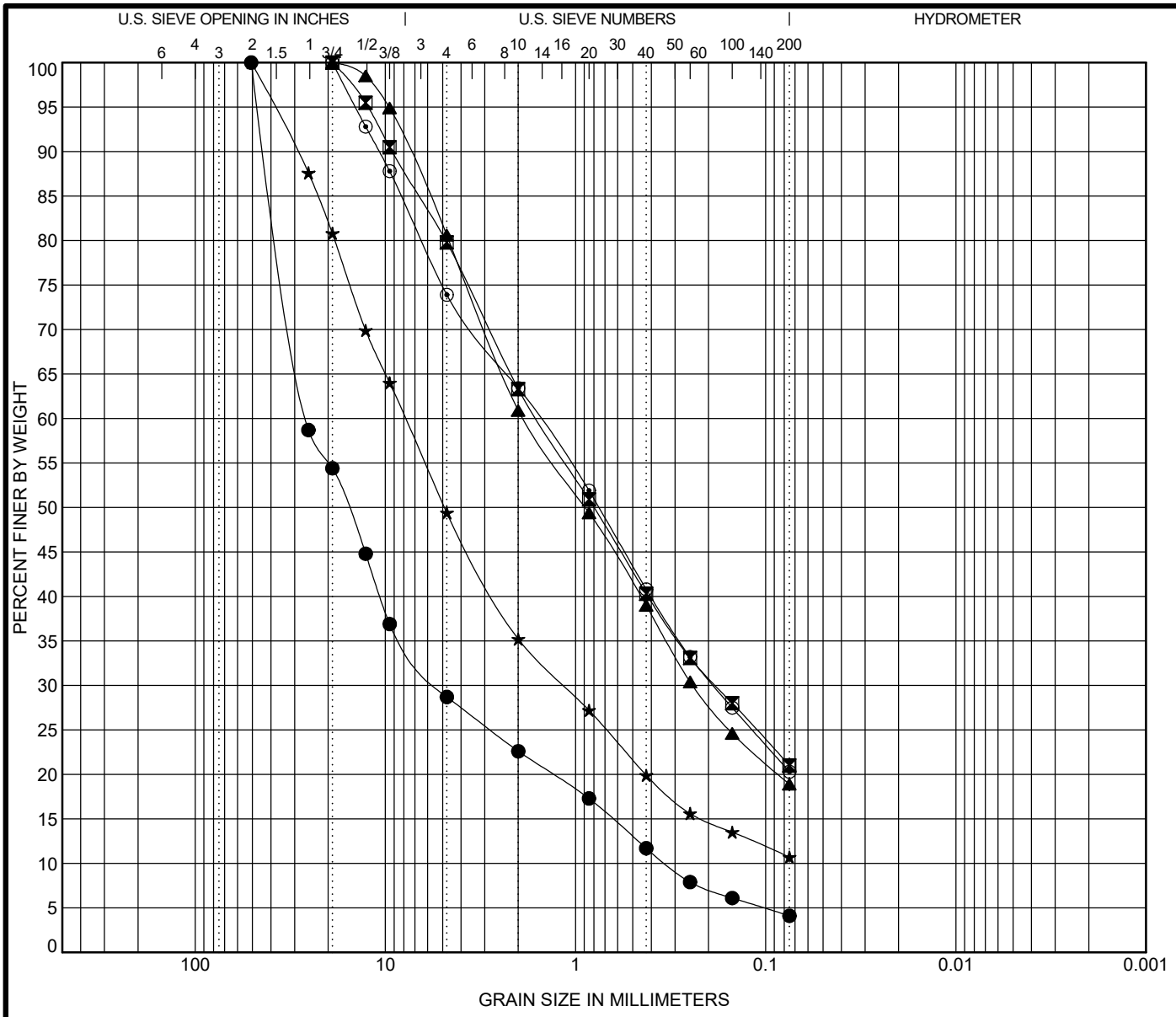
GRAIN SIZE DISTRIBUTION

Project: Construct Taxiway N & Improve Airport Drainage

Client: City of Palmer

Project Number: 18-001-15



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	LL	PL	PI	Cc	Cu
● HDL-29 DEPTH 5.9	**POORLY GRADED GRAVEL with SAND(GP)**				**3.23**	**77.45**
⊠ HDL-30 DEPTH 0.0						
▲ HDL-31 DEPTH 0.0						
★ HDL-32 DEPTH 3.3					**2.65**	**124.58**
⊙ HDL-33 DEPTH 0.0						

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● HDL-29 DEPTH 5.9	**50.8**	**25.96**	**5.302**	**0.335**	**71.3**	**24.6**	**4.1**	
⊠ HDL-30 DEPTH 0.0	**19**	**1.593**	**0.183**		**20.2**	**58.8**	**21.0**	
▲ HDL-31 DEPTH 0.0	**19**	**1.87**	**0.241**		**19.4**	**61.7**	**18.9**	
★ HDL-32 DEPTH 3.3	**50.8**	**7.857**	**1.147**		**50.6**	**38.7**	**10.7**	
⊙ HDL-33 DEPTH 0.0	**19**	**1.553**	**0.188**		**26.1**	**53.6**	**20.3**	

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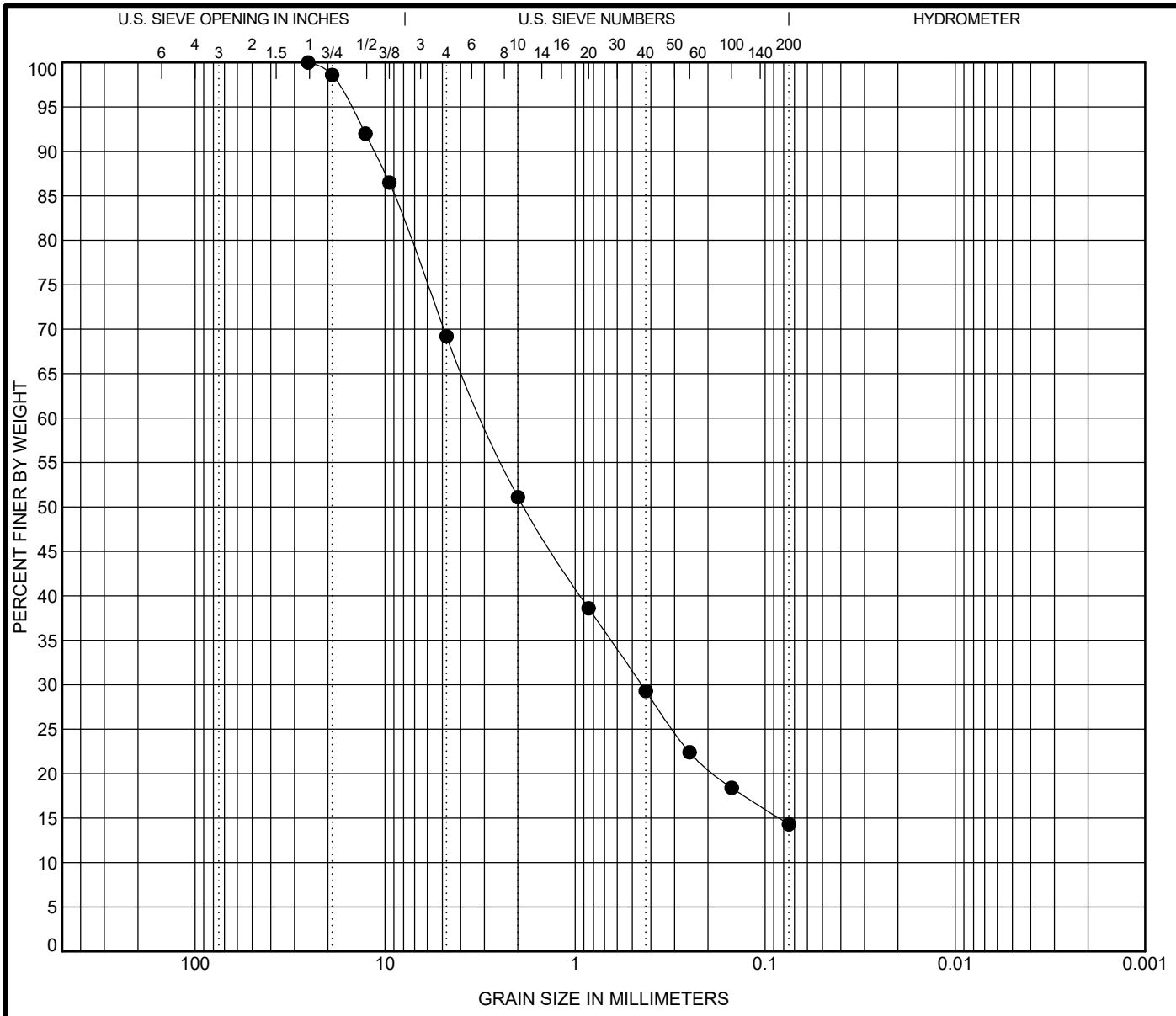
GRAIN SIZE DISTRIBUTION

Project: Construct Taxiway N & Improve Airport Drainage

Client: City of Palmer

Project Number: 18-001-15



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	**HDL-35 DEPTH 0.0**						

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**HDL-35 DEPTH 0.0**	**25.4**	**3.06**	**0.448**		**30.8**	**54.9**	**14.3**	

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GRAIN SIZE DISTRIBUTION

Project: Construct Taxiway N & Improve Airport Drainage

Client: City of Palmer

Project Number: 18-001-15

US GRAIN SIZE 18-001-15 PALMER TW N APRON E.GPJ HDL MODIFIED.GDT 3/11/22

Appendix F

Fleet Mix

PALMER AIRPORT – Taxiway N Aircraft Fleet Mix

Aircraft Type	FAARFIELD Designation	Design group	Takeoff Weight (lbs)	Estimated Annual Departures
Cessna 206	Cessna 206 Stationair	A-I	3300	18
Cessna 207	S-5	A-I	3800	5
DeHaviland DHC-2	S-5	A-I	5100	401
Casa 212	S-15	A-II	17000	241
Cessna 208	S-10	A-II	8000	717
Cessna 208B	Cessna 208B Grand Caravan EX	A-II	8750	10
Pilatus PC-12	S-10	A-II	10450	207
Douglas DC-3	DC3	A-III	25199	577
AC-500 Aero Commander	S-10	B-II	6750	89
AC-680FL Grand Commander	S-10	B-II	8500	173
AC-690 Twin Commander	S-10	B-II	10375	1359
Air Tractor AT-802	S-15	B-II	16000	226
Beech 1900 / 1900 C	D-15	B-II	16600	30
Beech King Air 200	Beechcraft King Air 300	B-II	12500	93
Beech King Air 90	Beechcraft King Air C90	B-II	10950	38
Dornier 228	S-12.5	B-II	12550	74
Gulfstream 695B	S-10	B-II	10325	452
Canadair CL215T	S-45	B-III	45250	351
Convair 580	D-50	B-III	54600	586
Dehaviland DHC-8	Q400/ Dash 8 Series 400	B-III	67200	9
BAE 146-200 / Avro RJ85A	Bae 146-300/300QC/300QT	C-III	97500	227
C-130	C-130	B-IV	155000	4
General Small Planes	S-3	A-I	2800	50000

Appendix G

FAARFIELD Software Analysis Results:

Taxiway N

Taxiway J

Apron E

Federal Aviation Administration FAARFIELD 2.0 Section Report

FAARFIELD 2.0.7 (Build 09/14/2021)

Job Name: Taxiway N

Section: TWN

Analysis Type: HMA on Aggregate

Last Run: Life Analysis 2021-11-18 12:47:49

Calculated Life = 26.1 Years

Total thickness to the top of the subgrade = 16.0in.

Pavement Structure Information by Layer

No.	Type	Thickness in.	Modulus psi	Poisson's Ratio	Strength R psi
1	P-401/P-403 HMA Surface	4.0	200000	0.35	0
2	P-209 Crushed Aggregate	6.0	48502	0.35	0
3	P-154 Uncrushed Aggregate	6.0	19264	0.35	0
4	Subgrade	0	15000	0.35	0

Airplane Information

No.	Name	Gross Wt. lbs	Annual Departures	% Annual Growth
1	S-3	2800	50000	0
2	Cessna 206 Stationair	3300	18	0
3	DC3	25200	577	0
4	Cessna 208B Grand Caravan EX	8750	10	0
5	Beechcraft King Air 300	12500	93	0
6	Beechcraft King Air C90	10950	38	0
7	BAe 146-300/300QC/300QT	97500	227	0
8	S-5	3800	5	0
9	S-5	5100	401	0
10	S-10	8000	717	0
11	S-10	10450	207	0
12	S-10	6750	89	0
13	S-10	8500	173	0
14	S-10	10375	1359	0
15	S-10	10325	452	0
16	S-15	17000	241	0
17	S-15	16000	226	0
18	D-15	16600	30	0
19	S-12.5	12550	74	0
20	S-45	45250	351	0
21	D-50	54600	586	0
22	Q400/Dash 8 Series 400	67200	9	0
23	C-130	155000	4	0

Additional Airplane Information

Subgrade CDF

No.	Name	CDF Contribution	CDF Max for Airplane	P/C Ratio
1	S-3	0.00	0.00	3.79
2	Cessna 206 Stationair	0.00	0.00	3.66
3	DC3	0.00	0.00	2.6
4	Cessna 208B Grand Caravan EX	0.00	0.00	3.45
5	Beechcraft King Air 300	0.00	0.00	2.44
6	Beechcraft King Air C90	0.00	0.00	3.29
7	BAe 146-300/300QC/300QT	0.66	0.66	1.62
8	S-5	0.00	0.00	3.57
9	S-5	0.00	0.00	3.57
10	S-10	0.00	0.00	3.21
11	S-10	0.00	0.00	3.21
12	S-10	0.00	0.00	3.21
13	S-10	0.00	0.00	3.21
14	S-10	0.00	0.00	3.21
15	S-10	0.00	0.00	3.21
16	S-15	0.00	0.00	2.99
17	S-15	0.00	0.00	2.99
18	D-15	0.00	0.00	2.38
19	S-12.5	0.00	0.00	3.09
20	S-45	0.01	0.01	2.7
21	D-50	0.00	0.00	1.79
22	Q400/Dash 8 Series 400	0.00	0.00	1.94
23	C-130	0.10	0.10	2.47

User Is responsible For checking frost protection requirements.

Federal Aviation Administration FAARFIELD 2.0 Section Report

FAARFIELD 2.0.7 (Build 09/14/2021)

Job Name: Taxiway E

Section: TW B J L

Analysis Type: HMA on Aggregate

Last Run: Life Analysis 2022-06-02 12:22:18

Calculated Life = 1325397.0 Years

Total thickness to the top of the subgrade = 15.0in.

Pavement Structure Information by Layer

No.	Type	Thickness in.	Modulus psi	Poisson's Ratio	Strength R psi
1	P-401/P-403 HMA Surface	3.0	200000	0.35	0
2	P-209 Crushed Aggregate	6.0	48502	0.35	0
3	P-154 Uncrushed Aggregate	6.0	19264	0.35	0
4	Subgrade	0	15000	0.35	0

Airplane Information

No.	Name	Gross Wt. lbs	Annual Departures	% Annual Growth
1	S-3	2800	50000	0
2	Cessna 206 Stationair	3300	18	0
3	Cessna 208B Grand Caravan EX	8750	10	0
4	Beechcraft King Air 300	12500	93	0
5	Beechcraft King Air C90	10950	38	0
6	S-5	3800	5	0
7	S-5	5100	401	0
8	S-10	8000	717	0
9	S-10	10450	207	0
10	S-10	6750	89	0
11	S-10	8500	173	0
12	S-10	10375	1359	0
13	S-10	10325	452	0
14	S-15	17000	241	0
15	S-15	16000	226	0
16	D-15	16600	30	0
17	S-12.5	12550	74	0

Additional Airplane Information

Subgrade CDF

No.	Name	CDF Contribution	CDF Max for Airplane	P/C Ratio
1	S-3	0.00	0.00	3.98
2	Cessna 206 Stationair	0.00	0.00	3.84
3	Cessna 208B Grand Caravan EX	0.00	0.00	3.61
4	Beechcraft King Air 300	0.00	0.00	2.51
5	Beechcraft King Air C90	0.00	0.00	3.42
6	S-5	0.00	0.00	3.73
7	S-5	0.00	0.00	3.73
8	S-10	0.00	0.00	3.34
9	S-10	0.00	0.00	3.34
10	S-10	0.00	0.00	3.34
11	S-10	0.00	0.00	3.34
12	S-10	0.00	0.00	3.34
13	S-10	0.00	0.00	3.34
14	S-15	0.00	0.00	3.1
15	S-15	0.00	0.00	3.1
16	D-15	0.00	0.00	2.44
17	S-12.5	0.00	0.00	3.21

User Is responsible For checking frost protection requirements.

Federal Aviation Administration FAARFIELD 2.0 Section Report

FAARFIELD 2.0.7 (Build 09/14/2021)

Job Name: Taxiway N

Section: Apron E

Analysis Type: HMA on Aggregate

Last Run: Life Analysis 2022-06-02 12:17:20

Calculated Life = 4185.1 Years

Total thickness to the top of the subgrade = 11.0in.

Pavement Structure Information by Layer

No.	Type	Thickness in.	Modulus psi	Poisson's Ratio	Strength R psi
1	P-401/P-403 HMA Surface	3.0	200000	0.35	0
2	P-209 Crushed Aggregate	4.0	40280	0.35	0
3	P-154 Uncrushed Aggregate	4.0	18299	0.35	0
4	Subgrade	0	15000	0.35	0

Airplane Information

No.	Name	Gross Wt. lbs	Annual Departures	% Annual Growth
1	DC3	25200	3500	0

Additional Airplane Information

Subgrade CDF

No.	Name	CDF Contribution	CDF Max for Airplane	P/C Ratio
1	DC3	0.00	0.00	3.08

User Is responsible For checking frost protection requirements.