GEOTECHNICAL INVESTIGATION REPORT

July 1, 2022

Prepared For:

Tectonic Engineering

Chester DPW
NY0248
Proposed 150-Foot Monopole Tower
Poplar Drive, Monroe (Orange County), New York 10950
Latitude N 41° 18' 26.3" Longitude W 74° 14' 16.5"

Delta Oaks Group Project GEO22-14312-08
Revision 1
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INTRODUCTION

This geotechnical investigation report has been completed for the proposed 150-foot monopole tower located at Poplar Street in Monroe (Orange County), New York. The purpose of this investigation was to provide engineering recommendations and subsurface condition data at the proposed tower location. A geotechnical engineering interpretation of the collected information was completed and utilized to suggest design parameters regarding the adequacy of the structure's proposed foundation capacity under various loading conditions. This report provides the scope of the geotechnical investigation; geologic material identification; results of the geotechnical laboratory testing; and design parameter recommendations for use in the design of the telecommunication facility's foundation and site development.

SITE CONDITION SUMMARY

The proposed tower and compound are located on a cleared lot within forested area exhibiting a gently sloping topography across the tower compound and subject property.

REFERENCES

- Civil Drawings, prepared by ARX Wireless, dated November, 9, 2021
- Soil Survey of Orange County, prepared by the USDA and NRCS
- TIA Standard (TIA-222-H)

SUBSURFACE FIELD INVESTIGATION SUMMARY

The subsurface field investigation was conducted through the advancement of one mechanical soil test boring to the auger refusal depth of 6.0 feet bgs. Samples were obtained at selected intervals in accordance with ASTM D 1586. The sampling was conducted at the staked centerline of the proposed tower. Upon encountering auger refusal 5.0 feet of rock coring was conducted in accordance with ASTM D 2113. Soil and rock samples were transported to our laboratory and classified by a geotechnical engineer in accordance with ASTM D 2487. A detailed breakdown of the material encountered in our subsurface field investigation can be found in the boring log presented in the Appendix of this report.

Additional testing was performed on selected samples in accordance with ASTM D 7012 (Unconfined Compressive Strength – Rock). Laboratory data can be found in the Appendix of this report.

Four auger probes were performed as well. Auger probes designated P-1 through P-4 encountered refusal at depths of 7.0, 5.0, 8.0, and 4.0 feet respectively.

A boring plan portraying the spatial location of the boring and probes in relation to the proposed tower, tower compound and immediate surrounding area can be found in the Appendix.

SUBSURFACE CONDITION SUMMARY

The following provides a general overview of the site's subsurface conditions based on the data obtained during our field investigation.

FILL

Fill material was encountered during the subsurface field investigation from the existing ground surface to a depth of 2.0 feet bgs. The fill material included silty sand.

SOIL

The residual soil encountered in the subsurface field investigation began at an approximate depth of 2.0 feet bgs in the boring and consisted of clayey sand. The materials ranged from a loose to very dense relative density.

Auger advancement refusal was encountered during the subsurface field investigation at a depth of 6.0 feet bgs.

ROCK

Rock was encountered during the subsurface investigation at a depth of 6.0 feet bgs. The rock can be described as highly fractured, slightly weathered, medium hard siltstone.

SUBSURFACE WATER

Subsurface water could not be measured during the subsurface investigation due to the use of mud rotary drilling techniques. The USDA soil survey of Orange County indicates approximate depth to groundwater within the site vicinity to be between two to three feet. However, subsurface water elevations can fluctuate throughout the year due to variations in climate, hydraulic parameters, nearby construction activity and other factors.

FROST PENETRATION

The frost penetration depth for Orange County, New York is 50 inches (4.2 feet).

CORROSIVITY

Soil resistivity was performed in accordance with ASTM G187 with a test result of 104,000 ohms-cm.

FOUNDATION DESIGN SUMMARY

In consideration of the provided tower parameters and the determined soil characteristics, Delta Oaks Group recommends utilizing a shallow foundation with rock anchors or a drilled shaft foundation for the proposed structure. The strength parameters presented in the following sections can be utilized for design of the foundation.

GENERAL SUBSURFACE STRENGTH PARAMETERS

Boring	Depth (bgs)	USCS	Moist/Buoyant Unit Weight (pcf)	Phi Angle (degrees)	Cohesion (psf)
B-1	0.0 – 2.0	FILL	115	--	--
	2.0 – 6.0	SC	110 / 48	30	0
	6.0 – 11.0	Siltstone	150	0	6,000

- The buoyant unit weight of soil should be utilized below a depth of 2.0 feet bgs.
- The unit weight provided assumes overburden soil was compacted to a minimum of 95% of the maximum dry density as obtained by the standard Proctor method (ASTM D 698) and maintained a moisture content within 3 percent of optimum.
- The values provided for phi angle and cohesion should be considered ultimate.

SUBSURFACE STRENGTH PARAMETERS – SHALLOW FOUNDATION

Boring	Dimensions (feet)	Depth (feet bgs)	Net Ultimate Bearing Capacity (psf)
B-1	5.0 x 5.0	5.0	21,460
		6.0	30,000*
	10.0 x 10.0	5.0	25,920
		6.0	30,000*
	Greater than 15.0 x 15.0	5.0	30,000
		6.0	30,000*

**Value assumes that foundation is bearing entirely on bedrock*

- Delta Oaks Group recommends the foundation bear a minimum of 5.0 feet bgs to extend beyond existing fill and frost penetration depth.
- A sliding friction factor of 0.35 can be utilized along the base of the proposed foundation.
- An Ultimate Passive Pressure Table with a reduction due to frost penetration to a depth of 4.2 feet bgs is presented on the following page.
- Delta Oaks Group recommends an appropriate factor of safety be utilized for the design of the foundation.

ULTIMATE PASSIVE PRESSURE VS. DEPTH - TOWER FOUNDATION

Soil Layers (feet)		Moist Unit Weight	Phi Angle	Cohesion	PV	KP	Ph
Top	0.0	115	0	0	0.00	1.00	0.00
Bottom	2.0	115	0	0	230.00	1.00	115.00
Top	2.0	110	30	0	230.00	3.00	345.00
Bottom	4.0	110	30	0	325.20	3.00	487.80
Top	4.0	110	30	0	325.20	3.00	487.80
Bottom	4.2	110	30	0	334.72	3.00	502.08
Top	4.2	110	30	0	334.72	3.00	1004.16
Bottom	6.0	110	30	0	420.40	3.00	1261.20
Top	6.0	150	0	6,000	420.40	1.00	12420.40
Bottom	10.0	150	0	6,000	770.80	1.00	12770.80

SUBSURFACE STRENGTH PARAMETERS – ROCK ANCHORS

Boring	Depth (bgs)	Rock Type	Ultimate Grout to Ground Bond Strength (psi)
B-1	0.0 – 6.0	--	--
	6.0 – 11.0	SILTSTONE	175

- The rock anchor design should extend into competent rock and have an adequate embedment length to resist the applied loads.
- Group effects can contribute to a reduction in resistance for the rock anchors and should be taken into consideration during foundation design.
- Delta Oaks Group recommends an appropriate factor of safety be utilized and the appropriate manufacturer recommendations be followed for the design of the rock anchors.

SUBSURFACE STRENGTH PARAMETERS - DRILLED SHAFT FOUNDATION

Boring	Depth (bgs)	Net Ultimate Bearing Capacity (psf)	Ultimate Skin Friction - Compression (psf)	Ultimate Skin Friction - Uplift (psf)
B-1	0.0 – 4.2	--	--	--
	4.2 – 6.0	--	110	80
	6.0 – 11.0*	53,760	2,400	2,400

**Subsurface strength parameters can be assumed similar beyond the boring termination depth for design purposes*

- The top 4.2 feet of soil should be ignored due to the frost penetration, the potential soil disturbance during construction, and the presence of fill material.
- The values presented assume the concrete is cast-in-place against earth walls and any casing utilized during construction of the foundation was removed.
- Delta Oaks Group recommends an appropriate factor of safety be utilized for the design of the foundation.

SEISMIC DESIGN CONSIDERATIONS

Period (seconds)	Site Coefficients	Mapped Spectral Acceleration Parameters	Adjusted Spectral Acceleration Parameters	Design Spectral Acceleration Parameters
0.2	1.3 (F_a)	S_s = 0.253	S_{ms} = 0.329	S_{Ds} = 0.219
1.0	1.5 (F_v)	S_1 = 0.058	S_{m1} = 0.087	S_{D1} = 0.058

- The site soils should be characterized as Seismic Site Class C
- Design considerations are based on the 2018 International Building Code and the subgrade conditions encountered during this investigation.

CONSTRUCTION

SITE DEVELOPMENT

The proposed access road and tower compound should be evaluated by a Geotechnical Engineer, or their representative, after the removal or "cutting" of the areas to design elevation but prior to the placement of any structural fill material to verify the presence of unsuitable or weak material. Unsuitable or weak materials should be undercut to a suitable base material as determined by a Geotechnical Engineer, or their representative. Backfill of any undercut area(s) should be conducted in accordance with the recommendations provided in the *STRUCTURAL FILL PLACEMENT* section of this report.

Excavations should be sloped or shored in accordance and compliance with OSHA 29 CFR Part 1926, Excavation Trench Safety Standards as well as any additional local, state and federal regulations.

STRUCTURAL FILL PLACEMENT

Structural fill materials should be verified, prior to utilization, to have a minimum unit weight of 110 pcf (pounds per cubic foot) when compacted to a minimum of 95% of its maximum dry density and within plus or minus 3 percentage points of optimum moisture. Materials utilized should not contain more than 5 percent by weight of organic matter, waste, debris or any otherwise deleterious materials. The Liquid Limit should be no greater than 40 with a Plasticity Index no greater than 20. Structural fill material should contain a maximum particle size of 4 inches with 20 percent or less of the material having a particle size between 2 and 4 inches. Backfill should be placed in thin horizontal lifts not to exceed 8 inches (loose) in large grading areas and 4 inches (loose) where small handheld or walk-behind compaction equipment will be utilized. The potential suitability of on-site materials to be utilized as fill should be evaluated by a Geotechnical Engineer, or their representative just prior to construction.

During construction structural fill placement should be monitored and tested. This should include at minimum, visual observation as well as a sufficient amount of in-place field density tests by a Geotechnical Engineer, or their representative. Materials should be compacted to a minimum of 95% of the maximum dry density as determined by ASTM D 698 (standard Proctor method). Moisture contents should be maintained to within plus or minus 3 percentage points of the optimum moisture content.

SHALLOW FOUNDATIONS

Foundation excavation(s) should be evaluated by a Geotechnical Engineer, or their representative, prior to reinforcing steel and concrete placement. This evaluation should include visual observation to verify a level bearing surface; vertical side-walls with no protrusions, sloughing or caving; and the exposed bearing surface is free of deleterious material, loose soil and standing water. Excavation dimensions should be verified and testing performed on the exposed bearing surface to verify compliance with design recommendations. Bearing testing should be conducted in accordance with ASTM STP399 (Dynamic Cone Penetrometer). A 6-inch layer of compacted crushed stone should be installed prior to reinforcing steel and concrete placement. If subsurface water is encountered during excavation dewatering methods such as sump pumps or well points may be required.

DRILLED SHAFT FOUNDATIONS

Drilled shaft foundations (caissons) are typically installed utilizing an earth auger to reach the design depth of the foundation. Specialized roller bits or core bits can be utilized to penetrate boulders or rock. The equipment utilized should have cutting teeth to result in an excavation with little or no soil smeared or caked on the excavation sides with spiral-like corrugated walls. The drilled shaft design diameter should be maintained throughout the excavation with a plumbness tolerance of 2 percent of the length and an eccentricity tolerance of 3 inches from plan location. A removable steel casing can be installed in the shaft to prevent caving of the excavation sides due to soil relaxation. Upon completion of the drilling and casing placement, loose soils and subsurface water greater than 3-inches in depth should be removed from the bottom of the excavation for the "dry" installation method. The drilled shaft installation should be evaluated by a Geotechnical Engineer, or their representative, to verify suitable end bearing conditions, design diameter and bottom cleanliness. The evaluation should be conducted immediately prior to as well as during concrete placement operations.

The drilled shaft should be concreted as soon as reasonably practical after excavation to reduce the deterioration of the supporting soils to prevent potential caving and water intrusion. A concrete mix design with a slump of 6 to 8 inches employed in conjunction with the design concrete compressive strength should be utilized for placement. Super plasticizer may be required to obtain the recommended slump range. During placement, the concrete may fall freely through the open area in the reinforcing steel cage provided it does not strike the reinforcing steel and/or the casing prior to reaching the bottom of the excavation. The removable steel casing should be extracted as concrete is placed. During steel casing removal a head of concrete should be maintained above the bottom of the casing to prevent soil and water intrusion into the concrete below the bottom of the casing.

If subsurface water is anticipated and/or weak soil layers are encountered drilled shafts are typically installed utilizing the "wet" method by excavating beneath a drilling mud slurry. The drilling mud slurry is added to the drilled shaft excavation after groundwater has been encountered and/or the sides of the excavation are observed to be caving or sloughing. Additional inspection by a Geotechnical Engineer, or their representative, during the "wet" method should consist of verifying maintenance of sufficient slurry head, monitoring the specific gravity, pH and sand content of the drilling slurry, and monitoring any changes in the depth of the excavation between initial approval and just prior to concreting.

Concrete placement utilizing the "wet" method is conducted through a tremie pipe at the bottom of the excavation with the drilling mud slurry level maintained at a minimum of 5 feet or one shaft diameter, whichever is greater, above the ground water elevation. The bottom of the tremie should be set one tremie pipe diameter above the excavation. A closure flap at the bottom of the tremie or a sliding plug introduced into the tremie before the concrete is recommended to reduce the potential contamination of the concrete by the drilling mud slurry. The bottom of the tremie must be maintained in the concrete during placement. Additional concrete should be placed through the tremie causing the slurry to overflow from the excavation in order to reduce the potential for the development of "slurry pockets" remaining in the drilled shaft.

QUALIFICATIONS

The design parameters and conclusions provided in this report have been determined in accordance with generally accepted geotechnical engineering practices and are considered applicable to a rational degree of engineering certainty based on the data available at the time of report preparation and our practice in this geographic region. All recommendations and supporting calculations were prepared based on the data available at the time of report preparation and knowledge of typical geotechnical parameters in the applicable geographic region.

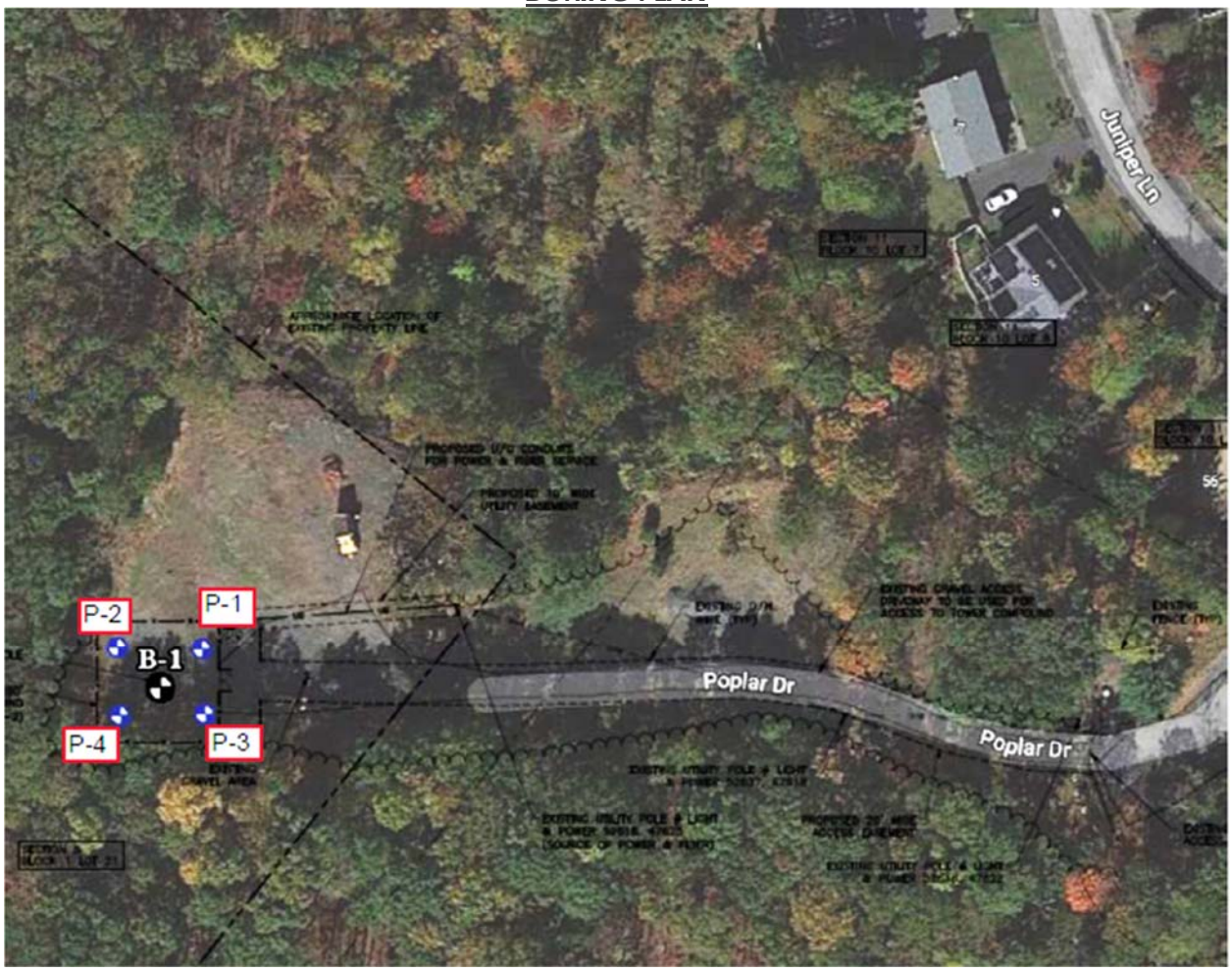
The subsurface conditions used in the determination of the design recommendations contained in this report are based on interpretation of subsurface data obtained at specific boring locations. Irrespective of the thoroughness of the subsurface investigation, the potential exists that conditions between borings will differ from those at the specific boring locations, that conditions are not as anticipated during the original analysis, or that the construction process has altered the soil conditions. That potential is significantly increased in locations where existing fill materials are encountered. Additionally, the nature and extent of these variations may not be evident until the commencement of construction. Therefore, a geotechnical engineer, or their representative, should observe construction practices to confirm that the site conditions do not differ from those conditions anticipated in design. If such variations are encountered, Delta Oaks Group should be contacted immediately in order to provide revisions and/or additional site exploration, as necessary.

Samples obtained during our subsurface field investigation will be retained by Delta Oaks Group for a period of 30 days unless otherwise instructed by Tectonic Engineering. No warranty, expressed or implied, is presented.

Delta Oaks Group appreciates the opportunity to be of service for this Geotechnical Investigation Report. Please do not hesitate to contact Delta Oaks Group with any questions or should you require additional service on this project.

APPENDIX

BORING PLAN



PROJECT NAME Chester DPW

PROJECT NUMBER GEO22-14312-08

PROJECT LOCATION Monroe, New York

CLIENT Techtonic Engineering

Boring No.: B-1

DATE DRILLED : 6/9/2022

DRILLING METHOD : Mud Rotary

GROUND ELEVATION :

BORING DEPTH (ft) : 11

GROUND WATER LEVELS:

AT TIME OF DRILLING : --- Not measured

AT END OF DRILLING : --- Not measured

AFTER DRILLING : --- Not measured

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE	MATERIAL CLASSIFICATION	Pocket Penetrometer (tsf)	BLOWS 1st	BLOWS 2nd	BLOWS 3rd	N VALUE
0.0	FILL - Medium dense, brown, gray, moist, fine to coarse grained, silty SAND (SM), with gravel		SM		4	5	7	12
2.5	Loose, tan, wet, fine to coarse grained, clayey SAND (SC), trace rock fragments		SC		4	4	5	9
5.0	--very dense, with SILTSTONE fragments				35	77	100	100
7.5	Dark gray, moist, fine grained, SILTSTONE, highly fractured, slightly weathered				REC = 85.4%	RQD = 85.4%		
10.0	Unconfined compressive strength: 7,600 psi							
12.5	Refusal at 6.0 feet. Bottom of borehole at 11.0 feet.							
15.0								

▲ SPT N VALUE ▲

10 20 30 40 50 60 70 80 90