

Leah Stephens
2371 Cherokee Ridge Way
Knoxville, TN 37920

April 30, 2019

Dr. Rebekah Page
Howard Baker Center
1640 Cumberland Ave. Knoxville, TN 37996

Dear Dr. Page,

Our senior design team was partnered with C2RL to perform engineering analysis and design for a substation foundation located in New Market, Tennessee. Based on the needs of the project, several areas of work within the civil engineering discipline had to be considered as a team. The foundation was designed to withstand the large loads of the electrical equipment while in the presence of subterranean voids from the abandoned zinc mine. Geo-structural analysis and design was necessary to address the loads and the soil stability for the foundation. The environmental regulations were enforced to ensure that the fluid containment infrastructure was considered in the case of failure to avoid contamination. The sub-station required the use of transformers of significant size, such that a failure causing a fluid leak would cause considerable environmental damage. A temporary traffic plan was developed for use during construction. This plan required an analysis of current traffic patterns to ensure that safe accommodations were met during the temporary conditions. This analysis was done through a transportation study completed at the site. Based on the study of the existing conditions and the requirements of the project, a plan to accommodate the temporary conditions was developed, including a temporary traffic plan

and construction entrances/exits. Finally, the construction schedule was created with consideration of equipment delivery and temporary roadways, and a cost analysis was produced in order to determine that the final design was reasonable in terms of the budget. My contribution to the project was the analysis and design of the substation from a structural perspective. I completed a series of hand calculations and utilized RISAFoundation software to arrive at an optimal solution. A 12 inch thick, 3000 psi concrete mat foundation with #5 bar reinforcement at the top and bottom of the slab, spaced at 18 inches, was selected as the final design. This design satisfied all structural and geotechnical requirements. My calculations for the project are available in Appendix A of the report, which is attached. The other students' work can be seen in the remaining appendices. A complete summary of my structural work can be seen in the "Structural Design" section of the report. I also worked with my team on each of their sections to help with technical writing and editing. In addition, I completed research on alternative foundation designs and compared each based on their benefits and costs.

Sincerely,

Leah Stephens

Senior, Civil and Environmental Engineering

Enclosed:

Appalachian Electric Cooperative Zinc Substation Foundation Project and Appendices

Appalachian Electric Cooperative Zinc Substation Foundation Project

Smoky Mountain Foundation Inc.



Authored by:

Grayson Layne, Ben Morris, Leah Stephens, James Throckmorton

The University of Tennessee, Knoxville

Tickle College of Engineering

Department of Civil and Environmental Engineering

CE 400: Senior Design Project Course

Graduating May 2019

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Timothy Siegel- Senior Principal Engineer at Dan Brown and Associates

Dr. Angel Palomino- Associate Professor at the University of Tennessee- Knoxville in CEE Department

Dr. Jennifer Retherford – Senior Lecturer at the University of Tennessee- Knoxville in CEE Department

Disclaimer

The investigation, results, and construction drawings compiled by Smoky Mountain Foundation Inc. for the Appalachian Electric Cooperative Zinc Substation Foundation project was for a senior design project for the University of Tennessee, Knoxville. The design solutions proposed within this report are to be used for academic purposes only and construction should not occur without complete review by a licensed engineer.

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Introduction

Smoky Mountain Foundation Inc. is a civil and environmental engineering student team dedicated to producing innovative and quality designs for engineering projects in order to best serve the needs of the clients, the community, and the environment. The team is made up of four senior civil and environmental engineering students from the University of Tennessee, Knoxville, as shown in Figure 1.1. The contact information for the student team is presented in Table 1.1.

This report contains the analyses and conclusions drawn by Smoky Mountain Foundation Inc. for the design solution for the Appalachian Electric Cooperative Substation Project working in partnership with C2RL. The scope of the project encompasses geotechnical site investigations, analyses of soil stability, structural design of the foundation, creation of a construction-ready drawing set, and an estimation of costs. Smoky Mountain Foundation Inc. worked collaboratively with multiple mentors, such as employees at CR2L and professors at the University of Tennessee, Knoxville, to accomplish this task. The contact information for the mentors on this project can be found in Table 1.2.



Figure 1.1: Smoky Mountain Foundation Inc. Team Members
(Left to Right) Grayson Lane, Ben Morris, James Throckmorton, and Leah Stephens

Name	Primary Position	Secondary Position	Number	Email
Ben Morris	Environmental Designer	Construction Designer	615-278-8121	rmorri34@vols.utk.edu
Grayson Layne	Construction Designer	Transportation Designer	423-326-4425	glayne1@vols.utk.edu
James Throckmorton	Geotechnical Designer	CADD Lead	615-495-5092	jthrockm@vols.utk.edu
Leah Stephens	Structural Designer	Technical Writer	561-779-2031	lsteph24@vols.utk.edu

Table 1.1: Student Contact Information

Name	Affiliation	Email
Qiang He	University of Tennessee, Knoxville	qianghe@utk.edu
Shuai Li	University of Tennessee, Knoxville	sli48@utk.edu
John Ma	The University of Tennessee, Knoxville	zma2@utk.edu
Danny Oliver	The University of Tennessee, Knoxville	doliver2@utk.edu
Angel Palomino	The University of Tennessee, Knoxville	apalomin@utk.edu
Jenny Retherford	University of Tennessee, Knoxville	jretherf@utk.edu
Chris Soro	C2RL	csoro@c2rl.com
Ron Whittaker	C2RL	rwhittaker@c2rl.com

Table 1.2: Faculty and Mentor Contact Information

Project Introduction

The Appalachian Electric Cooperative Zinc Substation Foundation project is located in New Market, Tennessee. Figure 2.1 illustrates the location of the project, while an existing site photograph facing southwest is presented in Figure 2.2. Based on Figure 2.2, the substation will be located in the background of the photo and will only utilize approximately half of the entire site. There is an abandoned zinc mine in the construction area which may impact the possible designs for the foundation. Members of Smoky Mountain Foundation Inc. team were tasked with performing engineering design services to address the needs of the project with efficiency and ingenuity. The project requires site investigation to capture the subsurface conditions. It is specifically important to take note of the known abandoned zinc mine and the observed hachured area, both of which may indicate further subsurface instability. Ultimately, the project requires engineering services in order to inform the contractor of the necessary infrastructure to accommodate the transformers, high side breakers, low side reclosers, and the control house. Lastly, the project requires the use of special and heavy equipment that must be accommodated in the final infrastructure design.

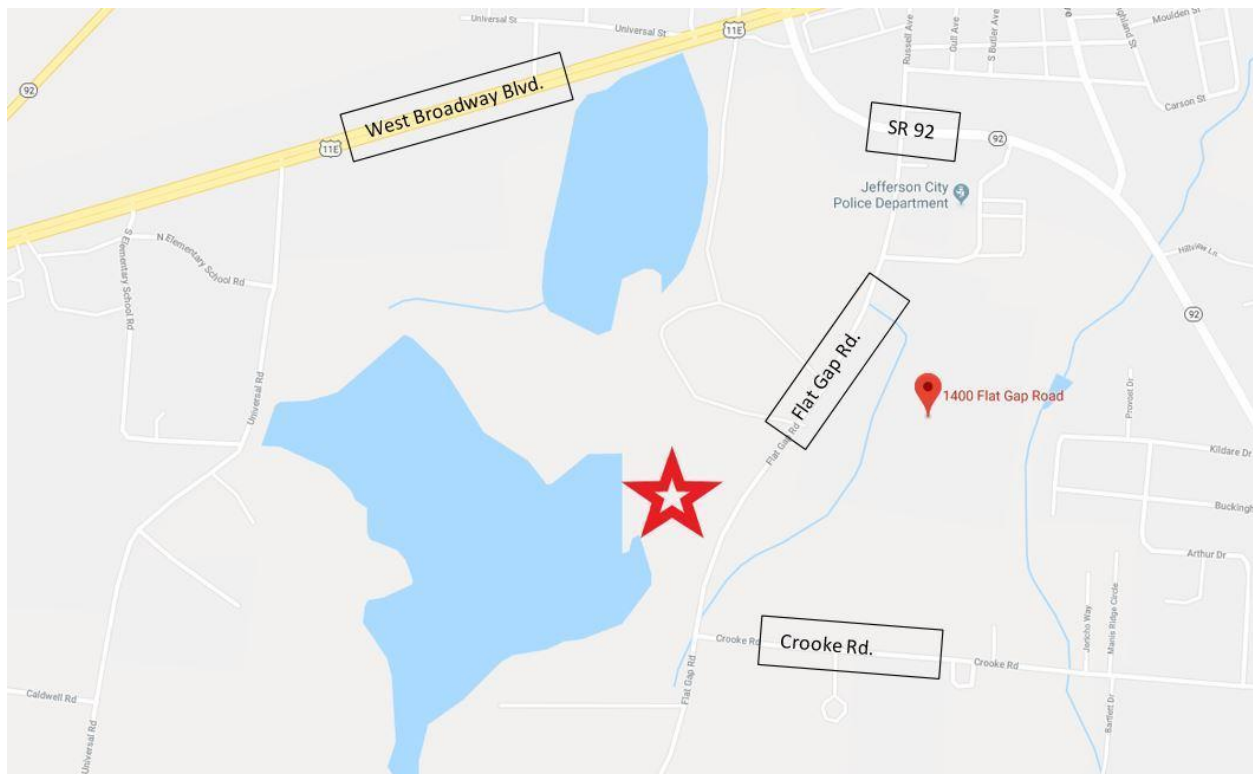


Figure 2.1: Location of Project



Figure 2.2: Current Condition of Site

Defined Scope of Work

Based on the needs of the project, several areas of work within the civil engineering discipline must be considered. The foundation is designed to withstand the large loads of the electrical equipment while in the presence of subterranean voids from the abandoned zinc mine. Thus, geo-structural analysis and design is necessary to address the loads and the soil stability for the foundation. The environmental regulations are enforced to ensure that the fluid containment infrastructure is considered in the case of failure to avoid contamination. The sub-station requires the use of transformers of significant size, such that a failure causing a fluid leak would cause considerable environmental damage. A temporary traffic plan is developed for use during construction. This plan requires an analysis of current traffic patterns to ensure that safe accommodations are met during the temporary conditions. This analysis was done through a transportation study completed at the site. Based on the study of the existing conditions and the requirements of the project, a plan to accommodate the temporary conditions was developed, including a temporary traffic plan and construction entrances/exits. Finally, the construction schedule is created with consideration of equipment delivery and temporary roadways, and a cost analysis is produced in order to determine that the final design is reasonable in terms of the budget.

Site Conditions

One of the initial tasks was to analyze the current site conditions. The project is located at the site of an abandoned zinc mine at 1414 Flat Gap Road, New Market, Tennessee. This mining efforts resulted in a large subsurface void that is located approximately 300 feet below the topsoil. The land above the mine was used for agricultural purposes after the mining efforts were abandoned and the land has a layer of organic alluvial top soil. Several hundred feet beneath the initial topsoil, there is a bedrock layer that consists of Mascot Dolomite, as determined by referencing the USGS Geological Map of the area, which can be found in Appendix B. In addition, the site slopes gently downhill from the southwest corner of the plot to the northeast corner. A hachured contour area located on the southeast corner of the lot was discovered. This area is visible from the surface and was located during a site walk through. This hachured area indicates the future possibility of a sinkhole and must be considered in the design. The site runs parallel with Flat Gap Road, which is a two-lane rural road with a speed limit of 45 mph. A railroad bridge spans across the road on the north side of the site. The bridge has been hit by passing traffic due to the low clearance of 15 feet. All of these conditions were considered throughout the analysis and design process.



Figure 3.1: Site Layout

Analysis and Design

The project required a design of a substation foundation; therefore, an analysis of the current site conditions was performed to obtain relevant data. The project was subdivided into geo-structural design, environmental and water system design, and construction design. In addition, a traffic study and analysis were completed to better prepare for possible construction impacts to the area.

Geotechnical Design

Geotechnical design is required for this project to account for soil stability issues in the design of the foundation and to determine the area's susceptibility to Karst topography. The foundation design considered the high loads of the electrical equipment, the soil conditions, and the abandoned zinc mine, such that a preferred solution could be identified.

Although it is known that the mine was built through dolomite bedrock, which would primarily indicate stable soil conditions, the location of the abandoned zinc mine brings the stability of the soil into question. Jefferson County is a geological region that contains Karst topography, according to USGS geologic data. This abundance of karst could impact the stability of the site even if the mine is deemed stable currently. The region is susceptible to carbonate erosion. Dolomite is classified as a carbonate and has a similar reaction to water as limestone. This reaction dissolves the carbonate material and could cause the mine's ceiling to become thinner over time. Without this vertical strength, the mine may experience deformation and possibly collapse, creating a void that could damage the substation. These possible issues were the motivating factor to determine soil strength and stability.

A geotechnical consultant from GEOServices was hired to perform the site investigation for the property. The consultant identified 10 boring locations from various areas of interest on the site. These borings were drilled between 25 ft and 35 ft into the soil, with one boring drilled 120 ft below the surface to analyze the bedrock and mine ceiling. Standard Penetration Test (SPT) and split-spoon sampling tests were conducted on these borings as well.

After boring was completed, laboratory work was conducted on specimens from the field to determine soil properties. Atterberg Limits were calculated, and the soil on site was found to be a clay of high plasticity, with a Plasticity Index of 50 on average. Using this data, the unit weight of the soil was determined to be between 110 pcf and 141 pcf. Considering the site consists mainly of this clay, an undrained condition was determined and a friction angle of zero was assumed. Cohesion of the soil was determined graphically using the Skempton Method and was calculated as 1600 psf.

Due to the results found from drilling and soil properties of the site, there are several precautions that have been taken. These precautions include: proper drainage

control of the site to eliminate water seepage into the mine, grading of the site to allow water runoff to drain into the retention pond to reduce the possibility of erosion damage to the bedrock, and cement capping of the bedrock below the site to prevent water damage to the mine. This cap prevents contact between the draining water and the mine's ceiling, reducing carbonate erosion. However, based on geotechnical data collected, this team recommends that this site is at no greater risk for sinkhole development than any other site. Therefore, this plan was deemed unnecessary and not cost effective to implement.

From recommendations from geotechnical advisers, any unusable soil, which would include any remaining vegetation and topsoil, will be removed and replaced by suitable gravel. TDOT D Stone is this team's recommendation for a strong and drainage friendly gravel covering. This gravel layer will cover the entire site to fully allow for drainage across the entire site. This layer will also reduce settlement under the foundation area, due to the much higher compressive strength of gravel when compared to the removed alluvial soil.

Design of the foundation system was performed to confirm limit states of bearing capacity, differential settlement, and total settlement. For the shallow foundation design for this project, this team's recommended allowable soil bearing capacity is 3,271 psf for the soil layer beneath the site. The bearing pressure of the foundation was calculated to be equal to 564 psf, indicating that the soil will provide sufficient strength for the load. The foundation will be placed 18 inches below the surface to protect from frost because the soil does not heave under the frost layer. Thawing causes the soil to heave which in turn causes settlement. The settlement leads to displacement in cladding and the superstructure which can cause aesthetic damage. By placing the foundation 18 inches below the surface, these issues can be avoided. From the allowable soil bearing pressure of the soil, total settlement should not exceed 1 inch, with a differential settlement of $\frac{3}{4}$ of an inch.

After reviewing all known data, several foundation design plans were considered by Smoky Mountain Engineering. One of these plans was a shallow foundation design. Considering that this foundation would need to support multiple pieces of electrical equipment over more than 50% of the site area, a mat foundation was determined to be an ideal shallow foundation design. Using this mat foundation, steel reinforcement would be relatively simple to install, minimizing labor costs and build time. This team also considered modification of the soil under the foundation to increase the allowable strength of the soil.

Another design option considered by Smoky Mountain Engineering was a deep foundation design. The two deep foundation options discussed included drilled shafts and micropiles. Drilled shafts offer greater strength and stability versus many other shallow foundation designs. Micropiles were considered a better option when compared to drilled shafts, offering much of the strength and stability of drilled shafts with much lower overall

costs. These piles are not drilled as deeply as drilled shafts, minimizing any disturbances to the mine below.

After careful consideration of all data collected and calculated for this site, this team decided to implement a mat foundation with no soil modification in the center of the site as seen in the drawings. This option was deemed to be the most cost and time effective course of action for the loads and soil strength determined. Besides the addition of gravel for drainage and soil grading, soil modification will not be considered for this foundation design. The location was chosen due to it having the least elevation change across the site, which allows for the least amount of excavation and fill to be at final grade. After reviewing data from Shelby Tube samples taken from the borings, much of the clay was found to be lean clay with a minimal expansive nature. Therefore, soil modification was deemed unnecessary to implement. Drilled shafts were deemed unnecessary because this type of foundation is very intrusive, time consuming, and expensive. The loads generated by the substation and its equipment do not warrant such methods. Drilled shafts could also disturb the zinc mine beneath the foundation site, creating unnecessary risks. Micropiles were also found to be unnecessary. The mine is over 120 ft below the surface, according to boring termination. With the mine being at such a depth and loads being relatively low, the use of micropiles or any deep foundation was determined to be too costly and too conservative for the parameters of the project. Also, based on a cost comparison of micropiles, deep foundations, and mat foundations with no soil modifications, the mat foundation was roughly 63% less expensive. Thus, a mat foundation will generate the strength necessary for all loads and will minimize settlement across the site, while also being the most financially reasonable.

This team has determined that from the all data obtained through drilling, laboratory testing, and calculations, a mat foundation will be the best design choice for this site. If all parameters of soil stability and design are taken into account, the team is confident in the functionality of this design.

Structural Design

Due to the large electrical equipment necessary for a substation, there are significant loading requirements applied to the foundation. The mat foundation was designed to support the point loads of the transformers, high side breakers, and low side reclosers, along with the distributed and area loads of the control room. Several limit states needed to be verified for the design of the mat foundation, specifically shear, flexure, 1-way shear, and punching shear.

As shown in Appendix A, the limit states were analyzed through a series of hand calculations and the use of RISA software. RISAFoundation was selected to perform structural analyses for this project by inputting site specific conditions to arrive at the optimal solution. Loading was based on values provided by C2RL from a previous project, Bean Substation, which had very similar project requirements. Loading information was gathered for the transformers, high side breakers, low side reclosers, and control house

based on the drawings found in Appendix A. In addition, the size of the entire project, a 40' by 50' footprint, was determined based on the dimensions of the equipment and control house and the available land space. Figure 4.1 shows an image of the model from RISAFoundation which was used to design the mat foundation. This image shows the layout of the site and equipment, with the estimated loads overlaid on top. The model was run and checked for each of the limit states, as described above, which it greatly exceeded. Figure 4.2 shows a visual of the soil pressure variation across the site. The soil pressure variation is fairly standard and illustrates that the loading is small compared to the strength of the design and soil integrity. In addition, outputs from this model can be seen in Appendix A.

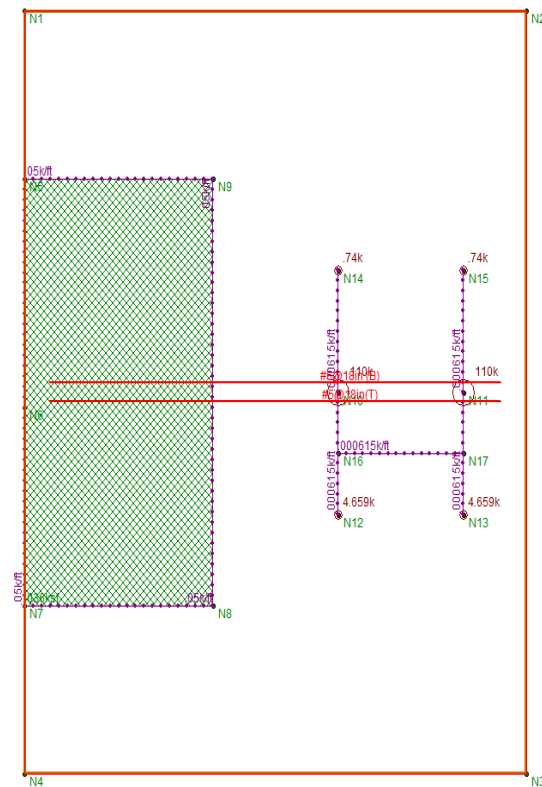


Figure 4.1: RISAFoundation Model Plan View

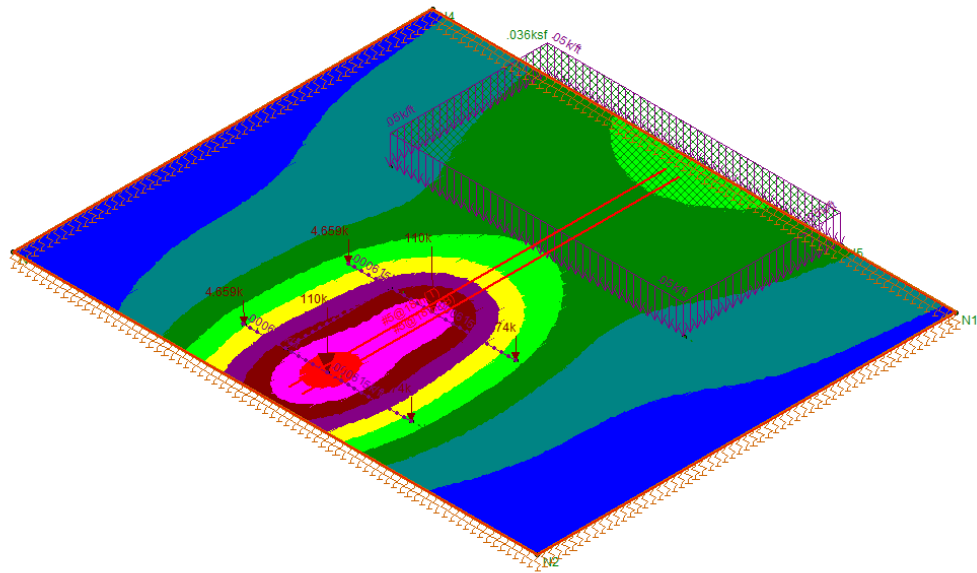


Figure 4.2: RISAFoundation Model Soil Pressure

Based on analysis with the RISAFoundation software, the final strength requirements were met. The final design requires a single the mat foundation with reinforcement. The reinforcement used will be #5 bars at the top and bottom of the foundation at 18 inch spacing. The slab is 12 inches thick and utilizes 3000 psi concrete. This design also satisfies the geotechnical limit states, as outlined in the geotechnical section. Full details for construction are presented in the accompanying construction-ready drawings.

Environmental Design

The existing site conditions and safety protocols for the electrical substation calls for an environmental design that will avoid contamination of local watersheds. The analysis includes the findings and observations of the environmental conditions and required actions from Smoky Mountain Foundations Inc. The requirements include a spill containment pond that will keep oil pollution out of the local storm water drainage system in case of substation failure.

As per the EPA's oil spill protection program, the Spill Prevention, Control and Countermeasure (SPCC), the site requires a spill containment area capable of holding the amount of oil held in the transformers and voltage regulators. The spill containment area is located at the lowest elevation of the site, in the Northeast corner of the property. The total storage volume for the spill containment pond is 244.8 cubic feet. This ensures all oil will be captured from the equipment in case of failure. The containment area is lined

with a geomembrane liner to contain any oil from permeating into the ground, while still allowing water to flow through.

Water Systems and Drainage Design

The water systems design required a plan for storm water drainage to make sure the site has no water collection areas, and that the plan does not overload the local storm water drainage infrastructure. As per the Tennessee criteria for storm water design, a 25-year storm is used to measure peak runoff from the lot. In the event of a 25-year 24-hour storm, the maximum rainwater runoff discharge by 5.75 cfs, according to calculations in Appendix D.

In order to ensure storm water is drained from the site appropriately, the team designed an appropriate grading plan. Once the location was determined for the concrete slab, the grading plan was then designed around it. Since a drainage ditch was already featured along the East perimeter of the lot in the pre-existing site conditions, Smoky Mountain Foundations designed a 2 percent grade, directing storm water runoff to the East side of the lot. This slope will allow some water to be absorbed by the lot, while directing excess to the adjacent storm water ditch. The local storm water drainage system is capable of containing the peak discharge during a 25-year, 24-hour storm for the designed 2 percent grade.

The pre-existing site conditions feature a hachured contour area in which runoff is directed into a void underground. All grading must be directed away from the depression to avoid any additional runoff to be discharged into the underground void. The final grading design, including the hachured contour area are featured in the proposed layout drawing.

Traffic Analysis

A traffic study was performed to determine any traffic safety issues impacting the construction site and to ensure that the current infrastructure of the traffic system is sufficient for the transportation of equipment and materials to the site. The purpose of this study is to identify any traffic safety and infrastructure issues that may be prevented in efforts to eliminate any delays in construction. The study included a review of current traffic volumes and speed along with lane width configurations and height clearance as necessary to confirm that the current infrastructure could sustain the special traffic of delivering the equipment and materials.

Traffic Study

The traffic study was performed on 10/25/2018 in order to observe the current traffic conditions and transportation infrastructure on a portion of Flat Gap road with a speed limit of 45 mph. The study was conducted at 7:30 AM to 9:00 AM in order to observe when the traffic volume would be at its assumed AM peak during the construction work hours of the project. The AM peak of traffic volume was used to assume to be consistent

with the PM peak traffic volumes based of traffic patterns that are linked to 9AM to 5PM work cycles. In order to adequately calculate the average speed of northbound and southbound traffic, a recording of an average time through a traffic study zone was chosen versus using a radar gun in order to be more discreet so that drivers would not slow down when they noticed someone checking their speed. The study consisted of setting two markers 200 feet apart, as shown in the drawings, creating a traffic study zone that northbound and southbound traffic traveled through and recording the time that local traffic took to travel through the zone. During the traffic study, traffic had a consistent free flow without any stoppage. The number of vehicles with time recordings traveling northbound and southbound can be seen in Appendix E. The recorded times were used to find the average speed of northbound and southbound traffic and are presented in Appendix E. The traffic study zone recorded a traffic volume of 123 vehicles per hour during peak AM times with an average speed of traffic traveling 38.77 mph.

Although the average speed was below the posted speed limit, Smoky Mountain Foundations Inc. is taking measures to slow the flow of traffic to increase the safety of the drivers and construction workers alike during delivery periods of equipment and material throughout the construction phase. During scheduled delivery periods, placing temporary construction speed limits of 25 mph for a 2 to 4 hour window along with construction warning signs to cause the drivers to drive more cautiously and at a slower speed for the time period. Reducing the vehicles speed from 45 mph to 25 mph will reduce the needed stopping sight distance from 360 feet to 115 feet, allowing the vehicles sufficient space to stop within the construction zone. Based off the MUTCD procedures, the construction warning signs will be placed 360 feet, per MUTCD Table 6C-2, away from the farthest north and south extents of the construction zone as shown on the Traffic Study drawing. The same warning signs will also be place at every 100 feet, per MUTCD Table 6C-1, approaching the construction site as shown on the Traffic Study drawing. Reducing the speed traffic and providing proper warning will ensure that the construction workers can safely enter and leave the site by allowing the normal traffic and construction works more time to react. This extra time is critical when construction vehicles are towing long trailers that take extended periods of time to maneuver in and out of the site.

Construction Management

Construction design is required for this project to accurately articulate the scheduling, sequencing, resources (labor, equipment, material) needed to construct the foundation within the allotted budget, and the completion date. The two major focuses on the construction design of this project was scheduling and quantity takeoffs. Scheduling the activities in the correct sequence was emphasized in order to prevent any delays. Correctly calculating the quantities of materials resulted in an accurate project value and duration.

Construction Scheduling

The critical path method (CPM), with an emphasis on using a linear path, was used to determine scheduling of each activity and duration of the project. The focus on using a linear path was chosen so that the floats of each activity could be minimized to reduce any lag periods or delays in the schedule. To determine the preliminary phases of the project and the activities of each phase, a work breakdown structure was constructed, which can be seen in Appendix F. The duration of each activity was calculated using the RS Means values of each activity. As appropriate, durations of some activities were determined based on quantity takeoffs from the design drawings and RSMeans values. The activities were scheduled in a sequencing order to establish the required work according to the necessary actions in the construction process which can be seen in Appendix F. Using CPM, the forward pass of the schedule was used to calculate the early start and finish of each activity, while the backward pass of the schedule was used to calculate the late start and finish of each activity. The schedule considered a working day Monday through Friday and 8 hours in length. Table 4.1 shows the three planned milestones along with the duration of each milestone.

Milestone	Number of Activities	Duration (days)
Temporary Construction Entrance	2	2
Site Development	8	27
Substation Foundation	7	23
Total	17	52

Table 4.1: Milestones with Number of Activities and Durations

Site Development

The excavation for the foundation had a calculated borrow of 26 cubic yards which is negligible considering the site had a total cut and fill of 1953 cubic yards. The 26 cubic yards of fill will be borrowed from a portion of the site where the final grade is not important to reduce cost and time. A 212' long by 137' wide oval staging area surrounding the foundation will be placed to accommodate the storage of material, equipment and contractor parking. The staging area can be seen on the Proposed Layout drawing. A 220' long by 20' wide temporary road will be used to connect Flat Gap Road and the staging area, as seen in the drawings. The staging area and temporary road will be constructed of 4" bedding of TDOT D Stone to support the loads displaced by construction vehicles and equipment.

A temporary construction entrance will be used to accommodate the trucks delivering the various substation equipment and machinery onto the site, due to their formidable weights and dimensions. These trucks displace a distributed load of up to 60 kips dispersed along the length of the truck and trailer on the entrance and staging area. The existing soil conditions would not be able to support the truck's load due to the stability of the current topsoil. A construction entrance was designed as a temporary

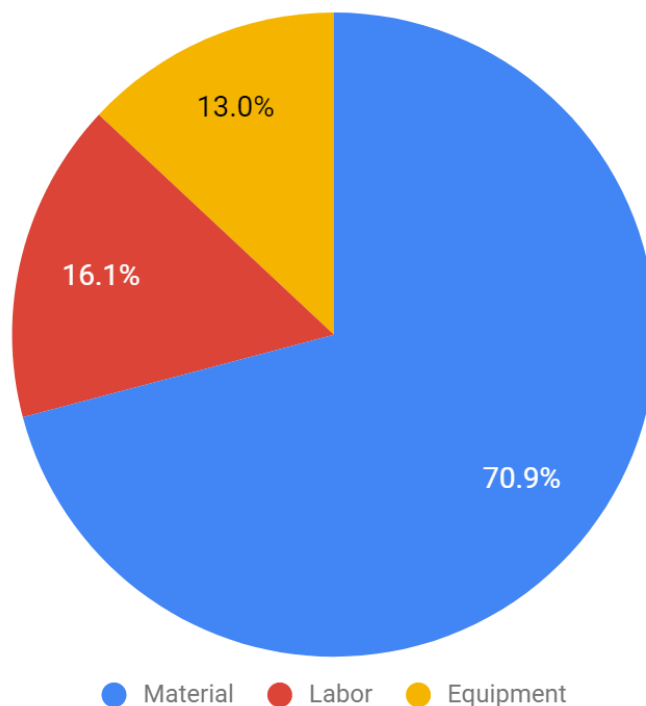
bridge using a 24" diameter Class 3 Concrete Pipe with an 8" bedding of TDOT D Stone and up to 18' of TDOT D Stone on top of the pipe. This design will allow the bridge to support an ultimate load of 4000 lbs. per horizontal linear foot of the bridge according to the CPDM. While many construction entrance configurations are feasible, a pipe and stone design that allows drainage across the entrance and ease of access into the site was selected to accommodate the anticipated 60 kip truck loads. The temporary construction entrance will be placed along the edge of Flat Gap Road and the center of the eastern side of the site which can be seen in the Construction Entrance drawing. This location was chosen to allow for a stopping site distance that allows traffic to adequately react to vehicles entering and leaving the construction site.

Erosion Control Plan

Smoky Mountain Foundation Inc. followed procedures in accordance to the Clean Water Act (CWA), the local standards for the Tennessee Department of Environment and Conservation. The team designed an erosion control plan to avoid local storm water drainage system overflow and pollution into local watersheds. A 3-foot-tall silt fence along the East and North perimeter was sufficient for the site because it satisfies EPA standards of 100 feet of fencing per $\frac{1}{4}$ acre, and the slope never exceeds a 3:1 slope gradient, as shown in Appendix D. The silt fence should be arranged as shown in the erosion control drawings.

Cost Estimate

Based on the design described previously, the cost was estimated. The costs associated with the project have been divided into three subcategories of labor, material, and equipment cost. A summary cost estimate with information such as unit, quantity, unit price, and total price has been provided in Appendix G. The largest contributors to the total cost is material with an estimated cost of \$138988.92. The total cost estimate for the project was determined to be \$196113.53. Figure 5.1 provides a visual illustration showing the cost breakdown per item. By breaking down the costs into three categories, labor, materials, equipment can be seen that materials provide the greatest portion of the total cost.



Division	Cost
Material	138988.92
Labor	31558.66
Equipment	25565.95
Total	196113.53

Figure 5.1: Item Cost Breakdown

Conclusion

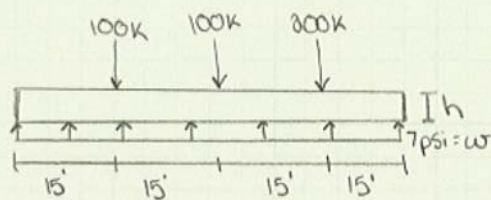
Smoky Mountain Foundations Inc. has proposed a mat foundation for the Appalachian Utility Board's substation project located in New Market, Tennessee. This foundation was the preferred solution from multiple options and satisfied the structural and geotechnical requirements. A spill containment pond was designed for the northwest corner of the lot to satisfy substation safety protocols. A uniform 2 percent grading plan towards the Northeast corner of the site, and away from the hachured area allowed for the most optimal drainage plan. The total duration of the project was calculated to be 52 working days. The costs for the project were also determined using the RSMeans and TDOT standard pricing index. Based on these values, the project will cost \$196113.53 in total to implement.

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Appendix A: Structural Calculations



$$L = 60'$$

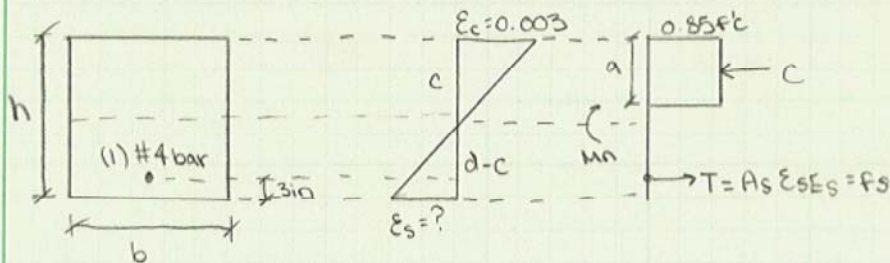
$$W = 40'$$

$$w = 7 \text{ psi}$$

$$f'_c = 4000 \text{ psi}$$

$$\frac{7 \text{ lb}}{\text{in}^2} (60' \times \frac{12''}{1'}) (40' \times \frac{12''}{1'}) = 2414.2 \text{ k}$$

$$\frac{150 \text{ lb}}{\text{ft}^3} (60') (40') (h) = 360 (h) \text{ k}$$



$$\text{Assume } f_s = f_y$$

$$\epsilon_s = \epsilon_y = 0.002$$

$$\frac{c}{0.003} = \frac{d-c}{0.002} ; d = h - 3$$

$$0.002c = 0.003(h - 3 - c)$$

$$0.005c = 0.003h - 0.009$$

$$0.005(0.00865) = 0.003h - 0.009$$

$$h = 3.01 \text{ in}$$

∴ unrealistic

$$\epsilon_s = \frac{d-c}{c} (0.001) = \frac{(0.01) - 0.00865}{0.00865} (0.003) = 0.000468$$

∴ Does not yield

∴ Do not need reinforcement

$$\sum M_{x=0} = 0 \rightarrow 100(15) + 100(30) + 200(45) - (2414.2)(30) + 360h(30) = 0$$

$$\rightarrow h = 5.47 \text{ ft} \approx 5.5 \text{ ft}$$

$$\frac{150 \text{ lb}}{\text{ft}^3} (60') (40') (5.5') = 1980 \text{ k}$$

$$100 \text{ k} + 100 \text{ k} + 200 \text{ k} + 1980 \text{ k} = 2380 \text{ k} \downarrow ; 2414.2 \text{ k} \downarrow$$

∴ Design can handle required loads with given allowable soil pressure and an $h = 5.5$ feet.

A

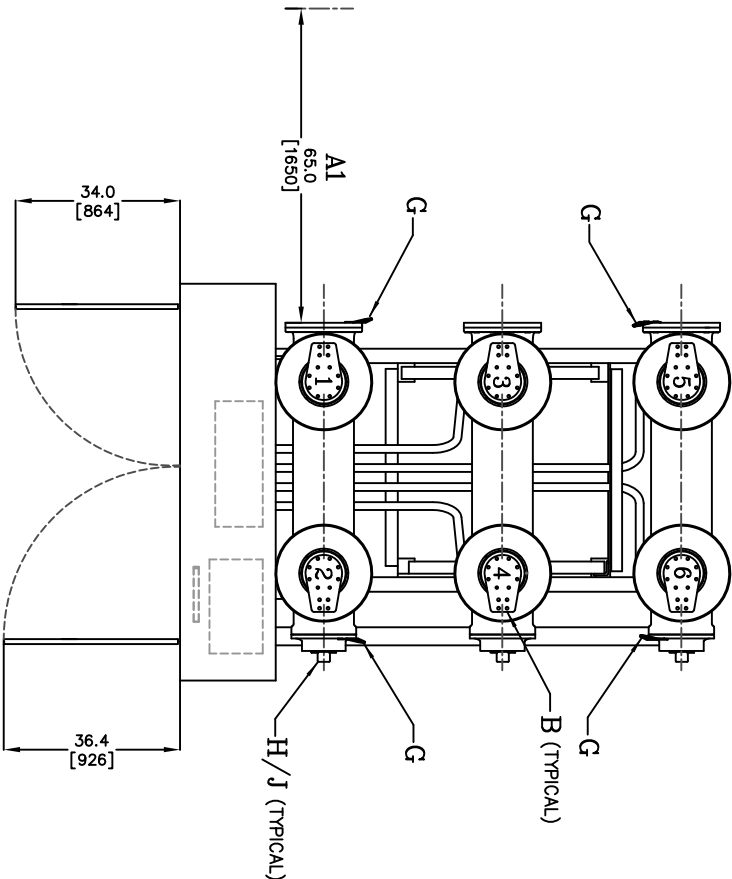
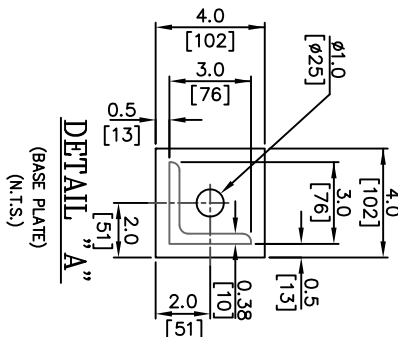
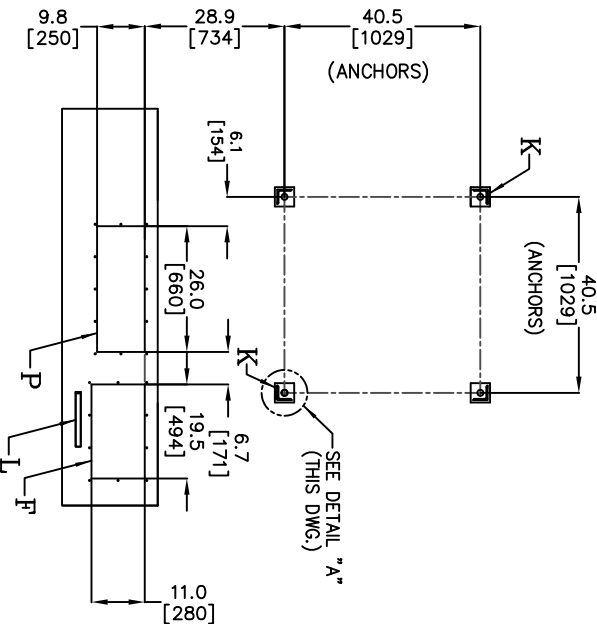
B

C

D

LEGEND

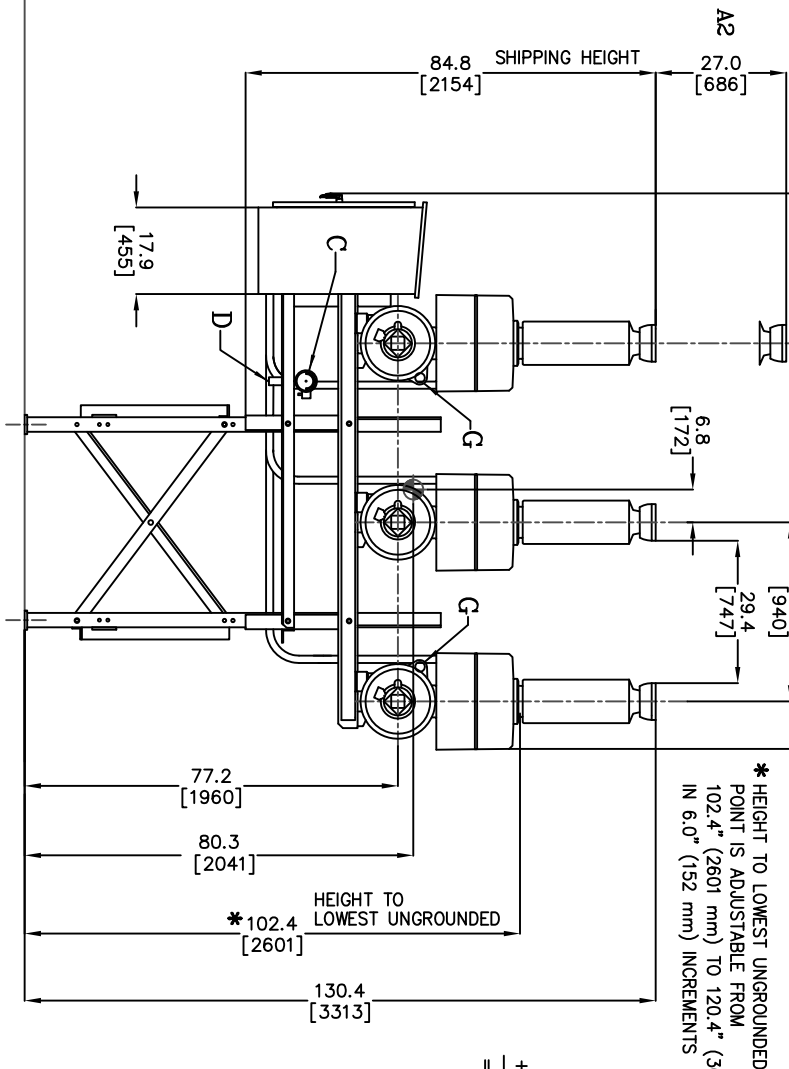
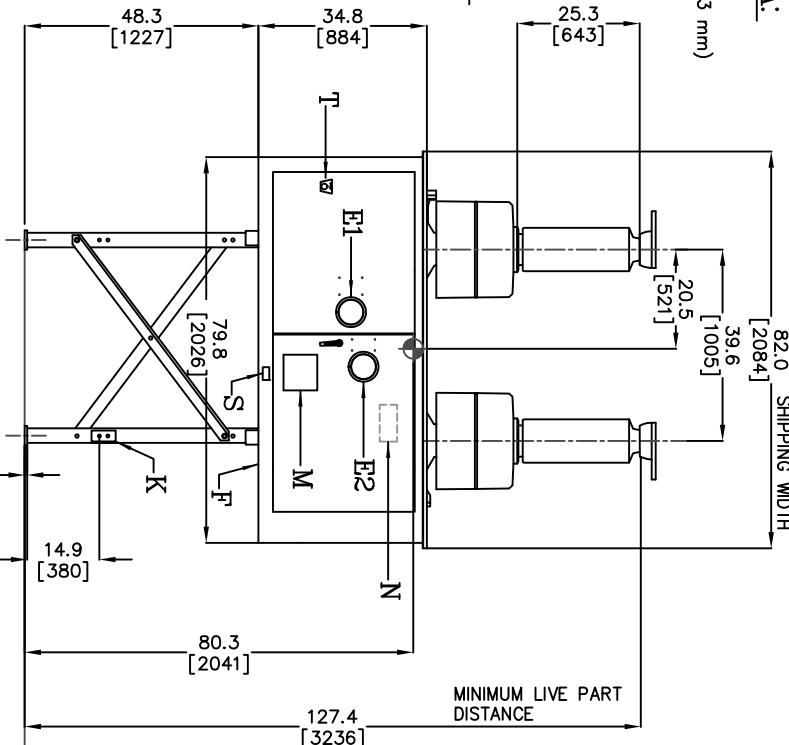
- A1 --- MINIMUM DISTANCE FOR INTERRUPTER REMOVAL
(65 inches / 1650 mm)
- A2 --- MINIMUM DISTANCE FOR BUSHING REMOVAL
(27 inches / 686 mm)
- B --- NEMA 4--HOLE TERMINAL PAD
- C --- SF6 DENSITY MONITOR
- D --- SF6 FILL VALVE (DILLO DN8)
- E1 --- CHARGED/DISCHARGE INDICATORS
- E2 --- OPEN/CLOSE INDICATORS & COUNTER
- F --- CABLE ENTRANCE
- G --- LIFTING LUGS
- H --- PRESSURE RELIEF (RUPTURE DISK TYPE)
- J --- MOLECULAR SIEVE
- K --- NEMA 2 GROUND PAD (DIAMETRICALLY OPPOSED)
- L --- CABINET GROUND BAR
- M --- RATINGS NAMEPLATE (EXTERNAL)
- N --- BCT NAMEPLATE (INTERNAL)
- P --- MECHANISM ACCESS PANEL
- S --- EXTERNAL GFI RECEPTACLE
- T --- EMERGENCY TRIP PUSHBUTTON

**PLAN VIEW****BUSHING DATA:**

CREEPAGE: 74" (1891 mm)
STRIKE DISTANCE: 25.3" (643 mm)
MATERIAL: PORCELAIN
COLOR: ANSI 70 GRAY

CABINET DATA:

RATING: NEMA 3R
MATERIAL: STEEL
COLOR: ANSI 70 GRAY



* HEIGHT TO LOWEST UNGROUNDED
POINT IS ADJUSTABLE FROM
102.4" (2601 mm) TO 120.4" (3058 mm)
IN 6.0" (152 mm) INCREMENTS

2,700 lbs (1,225 kg) --- BREAKER WEIGHT
29 lbs (13 kg) --- SF6 GAS WEIGHT
+ 1,930 lbs (876 kg) --- CT WEIGHT
= 4,659 lbs (2,114 kg) --- TOTAL WEIGHT

NOTES:

- 1) FOUR (4) 0.75" (19 mm) DIAMETER ANCHOR BOLTS REQUIRED.
- 2) 3.0" (76 mm) MINIMUM PROJECTION ABOVE FOUNDATION.
- 3) ANCHORING TO BE SUPPLIED BY OTHERS.
- 4) FOUNDATION TO BE LEVEL WITHIN 0.25" (6 mm) AT FOUR (4) BASEPLATES.
- 5) SHIM AND GROUT AS REQUIRED.
- 6) RATED LOW SEISMIC QUALIFICATION LEVEL PER IEEE-693 2005 (0.2g USED FOR ANCHOR BOLT CALCULATION)
- 7) OPERATIONAL FORCES IN ANY DIRECTION = 1100N (247 lbf)
- 8) HV TERMINAL STATIC HORIZONTAL FORCE (LONGITUDINAL) = 750N (169 lbf)
- 9) HV TERMINAL STATIC HORIZONTAL FORCE (TRANSVERSE) = 500N (112 lbf)
- 10) HV TERMINAL STATIC VERTICAL FORCE = 750N (169 lbf)

DIMENSIONS: INCHES
mm

TYPE:	DTI-72.5FK F1
IMPULSE WITHSTAND:	350 kV
MAXIMUM VOLTAGE:	72.5 kV
INTERRUPTER CURRENT RATING:	40 kA
CURRENT RATING:	1200 A

TOTAL SHEAR ON EACH FOUNDATION BOLT	2795 N	628 lbf
TOTAL TENSION ON EACH FOUNDATION BOLT	12002 N	2697 lbf
TOTAL FOUNDATION OVERTURNING MOMENT	22216 N-m	196626 lbf-in

MATERIAL ID:

CCD71-72.5FK-001

ORDER No.

239346

CUSTOMER: APPALACHIAN ELECTRIC COOPERATIVE
CUSTOMER ORDER No.: 13640
SUBSTATION: BEAN STATION 69-13kV SUBSTATION
SERIAL No.: 239346-010-A, 239346-010-B, 239346-010-C, 239346-010-D

CUSTOMER EQ. NO.:



Grid Solutions
One Power Lane
Charleroi, PA 15022

DRAWING No.:

M239346010

OUTLINE DRAWING

4

4

1

1

2

2

3

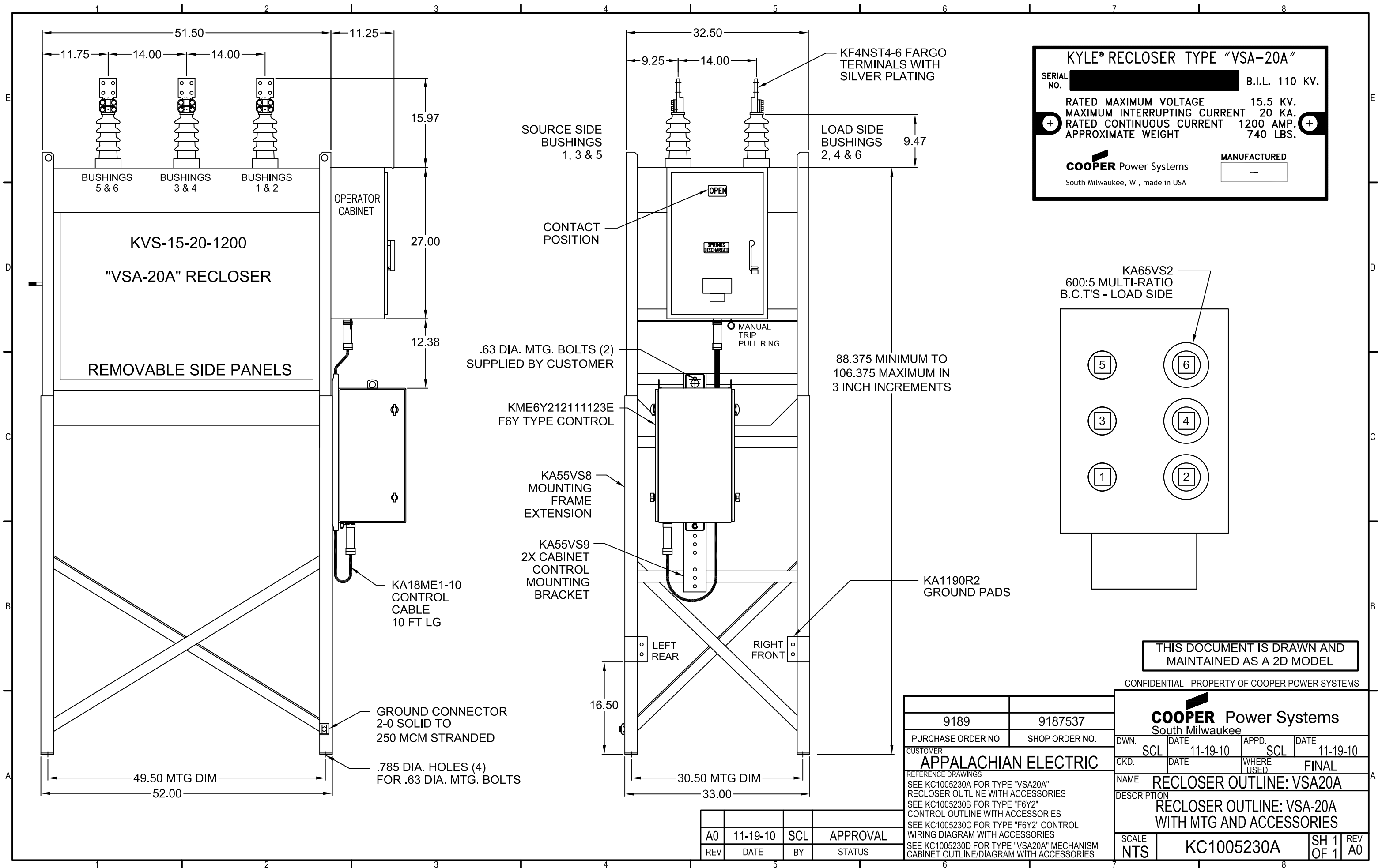
3

A

B

C

D



KYLE® RECLOSER TYPE "VSA-20A"

SERIAL NO. [REDACTED] B.I.L. 110 KV.

RATED MAXIMUM VOLTAGE 15.5 KV.
MAXIMUM INTERRUPTING CURRENT 20 KA.
RATED CONTINUOUS CURRENT 1200 AMP.
APPROXIMATE WEIGHT 740 LBS.

COOPER Power Systems
South Milwaukee, WI, made in USA

MANUFACTURED [REDACTED]

THIS DOCUMENT IS DRAWN AND MAINTAINED AS A 2D MODEL

CONFIDENTIAL - PROPERTY OF COOPER POWER SYSTEMS

9189		9187537		COOPER Power Systems	
PURCHASE ORDER NO.		SHOP ORDER NO.		South Milwaukee	
CUSTOMER	APPALACHIAN ELECTRIC	DWN.	SCL	DATE	11-19-10
REFERENCE DRAWINGS	SEE KC1005230A FOR TYPE "VSA20A" RECLOSER OUTLINE WITH ACCESSORIES	APPD.	SCL	DATE	11-19-10
	SEE KC1005230B FOR TYPE "F6Y2" CONTROL OUTLINE WITH ACCESSORIES	CKD.		WHERE USED	FINAL
	SEE KC1005230C FOR TYPE "F6Y2" CONTROL WIRING DIAGRAM WITH ACCESSORIES	NAME			
	SEE KC1005230D FOR TYPE "VSA20A" MECHANISM CABINET OUTLINE/DIAGRAM WITH ACCESSORIES	DESCRIPTION			
		RECLOSER OUTLINE: VSA20A			
		RECLOSER OUTLINE: VSA-20A WITH MTG AND ACCESSORIES			
SCALE	NTS	KC1005230A		SH 1 OF 1	REV A0

EQUIPMENT LIST			DESCRIPTION	
IT #	QTY	MANUF. P/N		
1	1		DOOR 4080 18GA GALV UH BLANK 4'-1/2" X 4'-1/2" HINGE CLSR REINFORCED PRIME PAINTED	
2	1	CECO	DOOR 3 X 7 INSULATED STEEL 20GA PAINTED WHITE FOR INTERIOR (STD)	
3	1	1871A65	DOOR ROLL, 12-1/8" LG X 1/2" DIA ALUMINUM MCMASTER (STD)	
4	3	VSL 2403 WS PAK	DOOR, LITE KIT 24"W X 30"H 1-3/4" THICK DOOR BRONZE W/ CLEAR WRESHIELD GLASS & GLAZE TAPE AIR LOUVERS	
5	1	531UE26D	DOOR STOP, WITH HOOK BURNS (STD)	
6	1	4208FA6894291PEKCH-071C-LC 6PN	LOOKSET, PANIC PDQ 3/2"-4/0" DOOR W/EVER TRM & IC MORT HOUSING LESS CORE PDQ	
7	2	QO1121125G	LOAD CENTER, 100A WL 120/240VAC 1PH 12 POSITION SQ.D	
8	2	NQ42L2C	PANEL BOARD, 200A WB 120/240VAC 1PH 42 POSITION SQ.D	
9	1	W24H1-A08XP4XXE	HEAT PUMP, 2 TON 1PH 60A WITH 8KW HEAT BARD GRAY	
10	1	8403-068	THERMOSTAT, FOR HEAT PUMP AUTO CHANGEOVER BARD (STD)	
11	1	1426A41	DOOR STOP, FLOORMOUNT HALF DOME CHROME	
12	8	CR63521	RECEPTACLE, 20A 120V DUPLEX W/ORY HUBBELL (STD)	
13	1	WF36LED	LIGHT, 36W LED MEDIUM WALL PACK NSI	
14	1	ECRLEDM6	EMERGENCY/EEXIT LIGHT, 120/277VAC (2)HEAD LED WBATT, BACKUP LITHIONA (STD)	
15	2	EWL2LEDH12	EMERGENCY LIGHT, (2)HEAD LED WITH BATTERY BACKUP LITHIONA (STD)	
16	3	CS12211	SWITCH, 20A 120-277 TOGGLE SPST W/ORY HUBBELL	
17	1	AT1013030E240SXAXGLXP	BATTERY CHARGER, 30A 130VDC OUTPUT 240VAC INPUT W/ ALARMS HANDLE (CUSTOMER PROVIDED MC INSTALLED)	
18	15	4JC-100	BATTERIES, 100AH 125VDC (4 CELLS PER JAR) C&D (CUSTOMER PROVIDED MC INSTALLED)	
19	1	PURELOW 1000	EYEWASH STATION, SELF CONTAINED FEND-ALL	
20	1		SWITCH, 600VDC 3W NONFUSABLE (CUSTOMER SUPPLIED MC INSTALLED)	
21	1	WW #4C566	LOUVER, 12" X 12" MOTORIZED WITH DAYTON	
22	1	CE 12-DS	FAN, 12" EXHAUST 2750 CFM SHUTTER MTD WITH SCREENED HOOD TPI CORP	
23	6		RELAY PANEL (CUSTOMER PROVIDED MC INSTALLED)	
24	1		WINDOW 24"H X 36"W HORIZONTAL SLIDING W/ SCREEN	
25	1	64302	WALL POCKET, DEFLECTO	
26	4		GROUND PAD, 1/4" X 4" X 14" (NO HOLES) COPPERTINNED PLATE	
27	10	QC143A02	GROUND CLAMP, #4-300MCM DOUBLE WIRE TO FLAT BRONZE 2 PIECE WITH SS HARDWARE	
28	1	CBLENC-9 R2	ENCLOSURE, 30"W X 119"H X 20"D 20 GA GALV PAINTED GRAY W/ GSKT CVR	
29	1	ALJA-24V090-12	CABLE TRAY, 24"W X 4"THK 90 DEG VERT. OUTSIDE ELBOW 12" RADIUS FLG IN HUSKY	
30	2PCS	A9JA-24-144	CABLE TRAY, 24W" X 4" THK X 12' LONG ALUMINUM FLG IN HUSKY	
31	1PC	A9JA-18-144	CABLE TRAY, 18"W X 4"THK X 12' LONG FLG IN ALUMINUM HUSKY	
32	1PC	A9JA-12-144	CABLE TRAY, 12"W X 4"THK X 12' LONG FLG IN ALUMINUM HUSKY	
33	1	ALJA-24T18-12	CABLE TRAY, 24" HORIZ. REDUCING TEE TO 18", 4" THK WITH 12" RADIUS FLG IN HUSKY	
34	2	ALJA-24T12-12	CABLE TRAY, 24" HORIZ. REDUCING TEE TO 12", 4" THK WITH 12" RADIUS FLG IN HUSKY	
35	11	GC41A02	GROUND CLAMP, #4-300MCM SINGLE WIRE TO FLAT BRONZE 2 PIECE WITH SS HARDWARE	
36	60FT	580030	WIRE #2/0 BARE STRANDED COPPER	
37	8	ES1121	STRUT, 1-5/8" X 1-5/8" X 30" LONG SLOTTED ZINC PLATED	
38	2	ES1121	STRUT, 1-5/8" X 1-5/8" BY 24" LONG SLOTTED ZINC PLATED	
39	4	ES1121	STRUT, 1-5/8" X 1-5/8" BY 18" LONG SLOTTED ZINC PLATED	
40	28	SHC-100 2KIT	CABLE TRAY, HANGER CLIP 1" WIDE FLANGE ZP HUSKY (STD)	
41	100	PPS-S12	STRAP, GROUND CONDUCTOR SUPPORT 2" NYLON FOR HALO WIRE PANDUIT (STD)	
42	150FT	580011G	WIRE #6 STRANDED GREEN INSULATED	
43	1	SPA2092P	SPLIT CONTAINMENT, C&D	
44	50	ES12411	TYRAP MOUNTING BASE	
45	1	FPNS476-71	LIGHTING CONTRACTOR PHOTOCELL RECEPTACLE, 120V TWISTLOCK FISHER PIERCE	
46	1	9001KA2	CONTRACTOR BLOCK, 30MM 600VAC 10A NO. SQ.D	
47	1	9001KA3	CONTRACTOR BLOCK, 30MM 600VAC 10A NO. SQ.D	
48	1	5B104	240VAC 50A 2 POLE NO. CONTRACTOR, 208/ENCLOSURE	
49	1	FP-20	LIGHTING CONTRACTOR PHOTOCELL, 120V TWISTLOCK FISHER PIERCE	
50	2	9001KR1U	PUSH BUTTON, METAL 30MM 600VAC 10A UNIVERSAL SQ.D	
51	1	CP463L20A5A14A0	CONTRACTOR, 240V 2P NO. NEMA 1 GE	
52	1	CLS #7100-BC-DSHQ-689 ANGLE #989011	DOOR CLOSER, HNY DUTY W/THUMB TURN HOLD OPEN ARM ALUM AMERICAN ANGLE AND REINFORCEMENT ANGLE NARROW FRAME BRACKET PDQ FOR EXTERIOR DOORS	
53	1	HCM60912N	PANEL BOARD, 225A LUG 125VDC LINE 99" SQ.D	
54	2	DTU326	SWITCH, 600A 240VAC 3P MTS N1 SQ.D (CUSTOMER SUPPLIED MC INSTALLED)	
55	1	CTAF#20-12-Q	COMPRESSION FITTING, #2/0 TO #6 WIRE PANDUIT	
56	1	WM#2EB16	THERMOSTAT, LINE VOLTAGE 120V FOR EXHAUST DAYTON (STD)	
57	17	LOC6-14A-L	CRIMP CONNECTOR (2) HOLE FOR #6 WIRE	

58	1	C-866SCP	ENCLOSURE, 8"H X 6"W X 6" D TYPE 1 PAINTED C&I
59	1	1A491	RELAY CONTRACTOR, 120VAC COIL DPDT 25A CONTACTS FOR EXHAUST SYSTEM OVERRIDE DAYTON
60	1	MR136 PFEF	LOOKSET, MORTISE 626 WITH SFIC CYLINDER LESS CORE PDQ NONLOOKING
61	8	AWM4-232-EU	LIGHT, INTERIOR FLUORESCENT 48" (2) 18 BULB 120/277V W/DEFUSER COLUMBIA (STD)
62	1	RDB0803-7-3EP2P	BATTERY RACK, TWO STEP TIER ZONE 3A W/ ENVIRONMENTAL PROTECTION
63	1		DOOR AVENING, 60" X 48" X .125 ALUMINUM
64		HGD 2	HYDROGEN DETECTOR, 120VAC WITH DUAL ALARM CONTACTS SOUTH SOURCE SALES (STD)

PACK IN SHEL TER	
A	1
B	8
C	1
D	1
E	1

NOTES:

- 1)MAIN DISCONNECT GROUND WIRE MUST BE ATTACHED TO GROUNDING SYSTEM BEFORE APPLYING POWER.
- 2)ALL WIRE AMPACITIES BASED ON TABLE 310-16 NEC, 310-15(b)(2)(a). ALL WIRE IS RATED AT 90°C W/75°C RATED LUGS. CONDUIT FILL BASED ON ANNEX C NEC(TABLE C1).
- 3)ALL SERVICE ENTRANCE EQUIPMENT SHALL BE LISTED FOR IT'S USE.
- 4)LOCAL BUILDING OFFICIALS: ALL THE ITEMS THAT ARE NOT COVERED IN THE APPROVAL PROCESS ARE TO BE SITE INSTALLED. ALL SITE INSTALLED ITEMS ARE SUBJECT TO LOCAL REVIEW, APPROVAL AND INSPECTION PROCESS.
- 5)DOOR LOCKSET INSIDE LEVER HAS AN ANSI F13 FUNCTION THAT RETRACTS LATCH AND DEADBOLT UPON ROTATION OF LEVER.
- 6)ALL ITEMS THAT ARE SITE INSTALLED ARE SUBJECT TO LOCAL REVIEW, APPROVAL AND INSPECTION ON SITE BY LOCAL AUTHORITY HAVING JURISDICTION.
- 7)USE 18 AWG THHN WIRE FOR ALL ALARM WIRES.
- 8)AFTER FABRICATION OF UNISTRUT AND ALL THREAD ROD SPRAY WITH ZINC-IT PRIMER.
- 9)IF BATTERIES WITH AN ELECTROLYTE CAPACITY OF MORE THAN 50 GALLONS ARE TO BE INSTALLED WITHIN THIS BUILDING, ONE OF THE FOLLOWING ALTERNATIVES MUST ALSO BE INSTALLED: 1.) AN EXHAUST FAN WITH A HYDROGEN LIMIT SWITCH SO THAT TO LIMIT THE HYDROGEN TO 1% OF THE TOTAL VOLUME OF THE ROOM; OR 2.) CONTINUOUS VENTILATION SHALL BE PROVIDED AT A RATE NOT LESS THAN 1 CUBIC FOOT PER MINUTE PER SQUARE FOOT OF FLOOR AREA OF ROOM.
- 10)ANY CHEMICALS TO BE STORED IN THIS BUILDING SHALL NOT EXCEED AMOUNTS LISTED IN TABLES 307.1(1) AND 307.1(2) OF THE INTERNATIONAL BUILDING CODE.

 – INDICATES RECEPTACLE GROUP.

TENNESSEE PROJECT DATA

DESIGN CODES:
2006 INTERNATIONAL BUILDING CODE
2006 INTERNATIONAL MECHANICAL CODE
2006 INTERNATIONAL PLUMBING CODE
2006 INTERNATIONAL FUEL GAS CODE
2006 INTERNATIONAL FIRE CODE
2008 NATIONAL ELECTRICAL CODE
2006 INTERNATIONAL ENERGY CONSERVATION CODE PER SECTION 501.2, USE ASHRAE/IESNA 90.1 2004 SECTION 2.3c – EXEMPT
TENNESSEE PUBLIC BUILDINGS ACCESSIBILITY ACT, I.C.A. 68-120-2

DESIGN LOADS:	
FLOOR LIVE LOAD (THROUGHOUT)	110 PSF (OPTIONAL 200 PSF)
FLOOR DEAD LOAD MAX. (THROUGHOUT)	36 PSF
ROOF LIVE LOAD	50 PSF
ROOF DEAD LOAD	52.2 PSF
GROUND SNOW LOAD	41.3 PSF
FLAT ROOF SNOW LOAD	50 PSF
SNOW EXPOSURE FACTOR	1.2
SNOW LOAD IMPORTANCE FACTOR	1.0
THERMAL FACTOR	1.2
ULTIMATE WIND SPEED (3-SEC GUST)	150 MPH
SEISMIC IMPORTANCE FACTOR	1.0
RISK CATEGORY	II
BUILDING CLASSIFICATION	II
WIND EXPOSURE CATEGORY	C
INTERNAL PRESSURE COEFFICIENT	40.18
WIND LOAD (UPLIFT) (MWFRS)	62.9 PSF
WIND LOAD HORIZONTAL (C & C)	61.7 PSF
WIND LOAD HORIZONTAL (C & C)	39.8 PSF (ZONE 4)
WIND LOAD HORIZONTAL (WINDOW & DOOR)	81.6 PSF (ZONE 5)
WIND LOAD (UPLIFT) (C & C)	52.9 PSF (ZONE 2)
WIND LOAD (UPLIFT) (C & C)	91.9 PSF (ZONE 3)

SEISMIC IMPORTANCE FACTOR
1
SEISMIC USE GROUP
1
SPECTRAL RESPONSE ACCELERATION S_a
1.25
SPECTRAL RESPONSE ACCELERATION S_w
D
SEISMIC DESIGN CATEGORY
D
SITE CLASS
BASIC SEISMIC-FORCE RESISTING SYSTEM
DESIGN BASE SHEAR
ANALYSIS PROCEDURE
OCCUPANCY USE GROUP
CONSTRUCTION TYPE
MINIMUM SETBACK
BEARING WALL SYSTEM – SPECIAL
0.2W
EQUIVALENT LATERAL-FORCE PROCEDURE
S2
VB UNSPRINKLED
SEE NOTE 3 FOR COMMON OR ASSUMED
PROPERTY LINE TO COMPLY WITH
IBC TABLES 602 & 704.8

NOTES:

1. THE INTENDED OCCUPANCY OF THIS EQUIPMENT SHELTER IS FOR PERFORMING THE REQUIRED SERVICE/MAINTENANCE OF EQUIPMENT ONLY.
2. PER IBC 2006 TABLE 720.1(2), 4" SAND-LIGHTWEIGHT CONCRETE WALLS HAVE FIRE RESISTANCE RATING OF 2 HOURS WITH UNPROTECTED OPENINGS.
3. PER IBC 2006 TABLE 705.8, ANY WALL W/ 10% OR LESS OF UNPROTECTED OPENINGS MAY UTILIZE A SETBACK GREATER THAN 5'-0". ANY WALL W/ 15% OR LESS OF UNPROTECTED OPENINGS MAY UTILIZE A SETBACK GREATER THAN 10'-0". ANY WALL W/ 25% OR LESS OF UNPROTECTED OPENINGS MAY UTILIZE A SETBACK GREATER THAN 15'-0". ANY WALL W/ 45% OR LESS OF UNPROTECTED OPENINGS MAY UTILIZE A SETBACK GREATER THAN 20'-0". ANY WALL W/ UNPROTECTED OPENINGS MAY UTILIZE A SETBACK GREATER THAN 30'-0".
4. THIS SHELTER IS REQUIRED TO BE CONNECTED TO PUBLIC UTILITIES.
5. THE USE OF THIS SHELTER WITHOUT RESTROOM FACILITIES IS SUBJECT TO LOCAL REVIEW AND APPROVAL.
6. THESE STRUCTURES ARE NOT DESIGNED FOR FLOOD HAZARD AREAS.

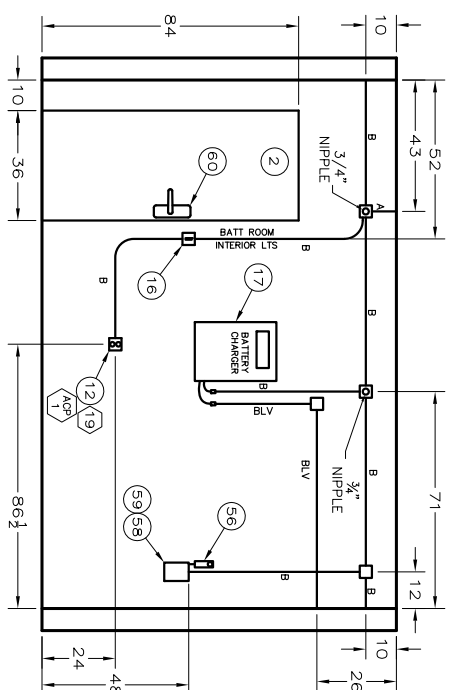
ITEMS TO BE SITE INSTALLED & SUBJECT TO LOCAL CODE REVIEW & COMPLIANCE AND ARE NOT INSPECTED BY THE THIRD PARTY: FOUNDATION, CONNECTION TO PUBLIC UTILITIES, SITE WORK, ETC.

FINISH COLOR SCHEDULE	
EXT. WALLS: EXPOSED AGGREGATE – GREYSTONE GRAY	
EXT. TRIM: MINDFUL GRAY COARSE	
EXT. DOORS: MINDFUL GRAY	
INT. WALL & CEILING: STANDARD FINISH	
INT. DOOR(S): SAME AS EXTERIOR COLOR	
FLOOR: URETHANE PAINTED GRAY W/ ANTSKID	

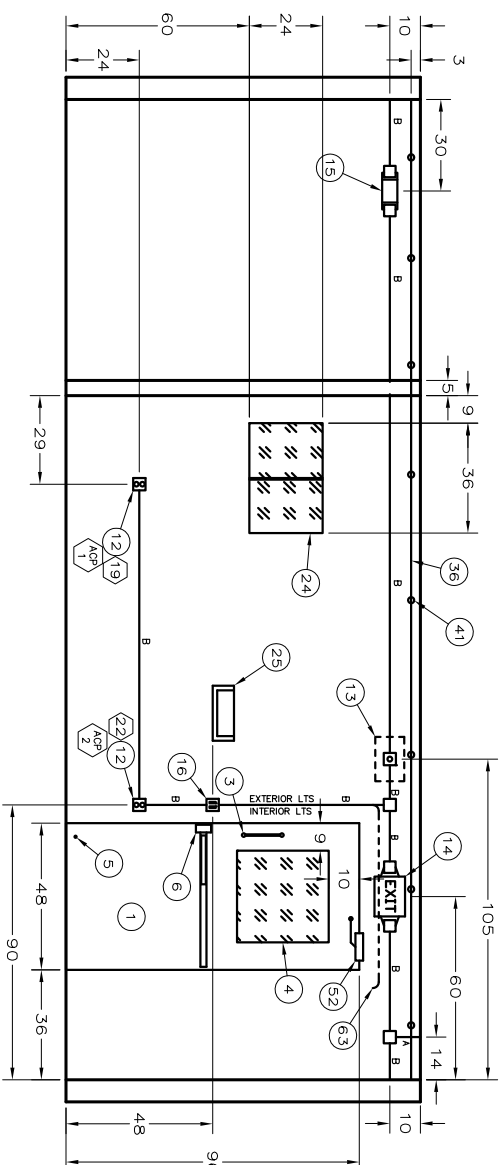
TN PLAN NUMBER: MODEL #MCL801
SITE: BEAN STATION, TN
"MAY BE BUILT MIRROR IMAGE"

R1	GENERAL REVISIONS	11-15-17	CRR
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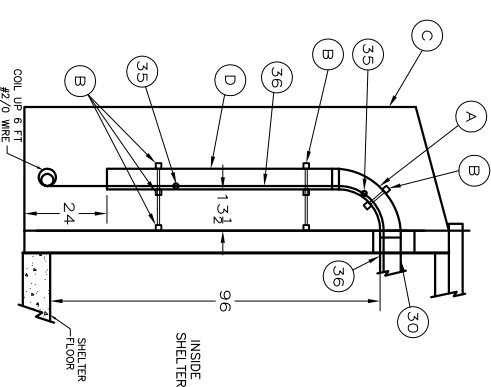
REV. NO.	DESCRIPTION	DRAWN BY	DATE	DATE	DNV BY
MODULAR CONNECTIONS, LLC					
1000 Industrial Blvd Bessemer, AL 35022		Phone: 205-980-4565 Fax: 205-980-5951 Email: info@modularconnections.com			
TITLE		SCALE		JOB NO.	
KVA, INC. EQUIPMENT UST FOR 16' X 28' X 9'8" IH SHELTER		NA		MCP983-MC4334	
NOTICE: These drawings and specifications are the property of Modular Connections, LLC. All information contained herein which is not known generally in the field of Modular Connections, LLC shall be confidential and shall remain the property of Modular Connections, LLC. No part of these drawings or specifications shall be reproduced, copied or used as the basis for the manufacture or sale of apparatus without written permission.		DRAWING NO.		SHEET	
		D16230 R1		01	



VIEW A



REAR SIDEWALL

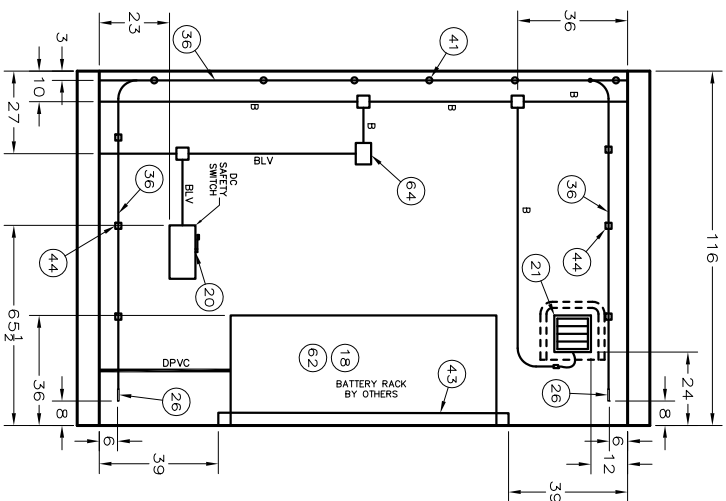


EXTERIOR CABLE TRAY DETAIL

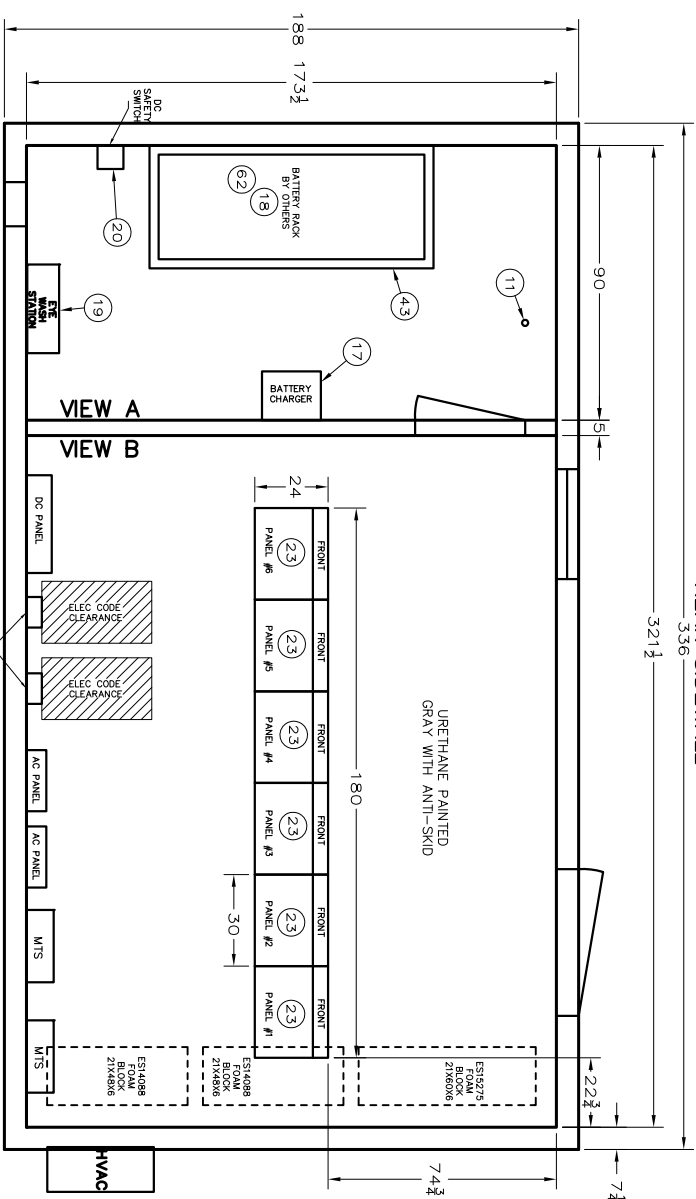
CONDUIT KEY	
(R) A = 1/2" (LV)	(R) G = 3" (LV)
(R) B = 3/4" (LV)	(R) H = 4" (LV)
(R) C = 1" (LV)	
(R) D = 1-1/4" (LV)	
(R) E = 2" (LV)	
(R) F = 2-1/2" (LV)	

NOTES:
 1) LV DESIGNATES LOW VOLTAGE CONDUIT.
 2) P* DESIGNATES PVC CONDUIT.

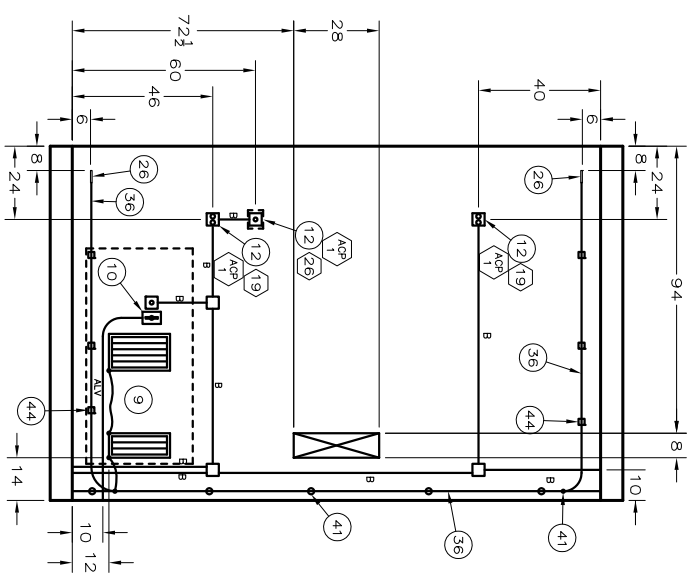
STANDARD CONDUIT FITTINGS ARE DIECAST
SET-SCREW TYPE EMT FITTINGS UNLESS
SPECIFIED OTHERWISE ON DRAWING



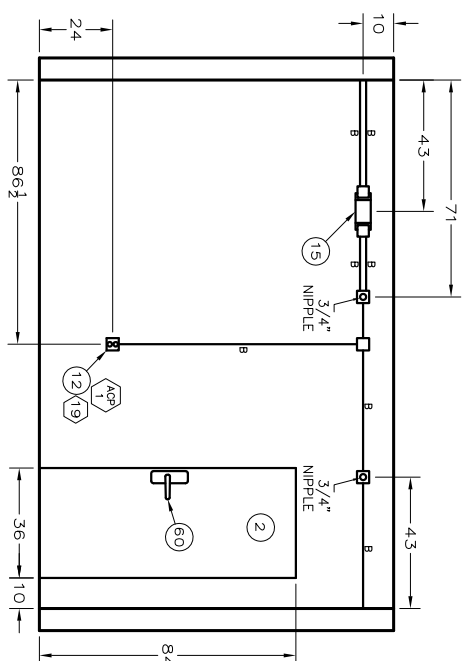
LEFT ENDWALL



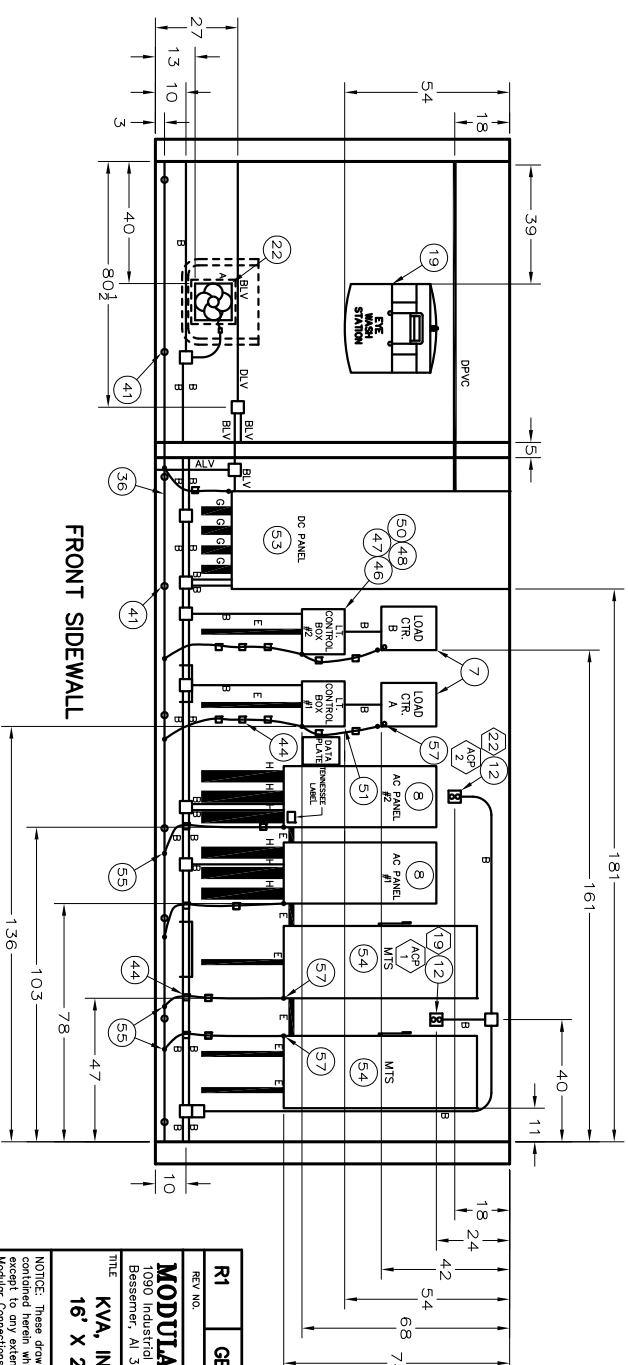
FLOOR – 200PSF LOAD



RIGHT ENDWALL



VIEW B



FRONT SIDEWALL

R1	GENERAL REVISIONS	11-15-17	CR
----	-------------------	----------	----

TN PLAN NUMBER: MODEL #MCL80
SITE: BEAN STATION, TN
"MAY BE BUILT MIRROR IMAGE"

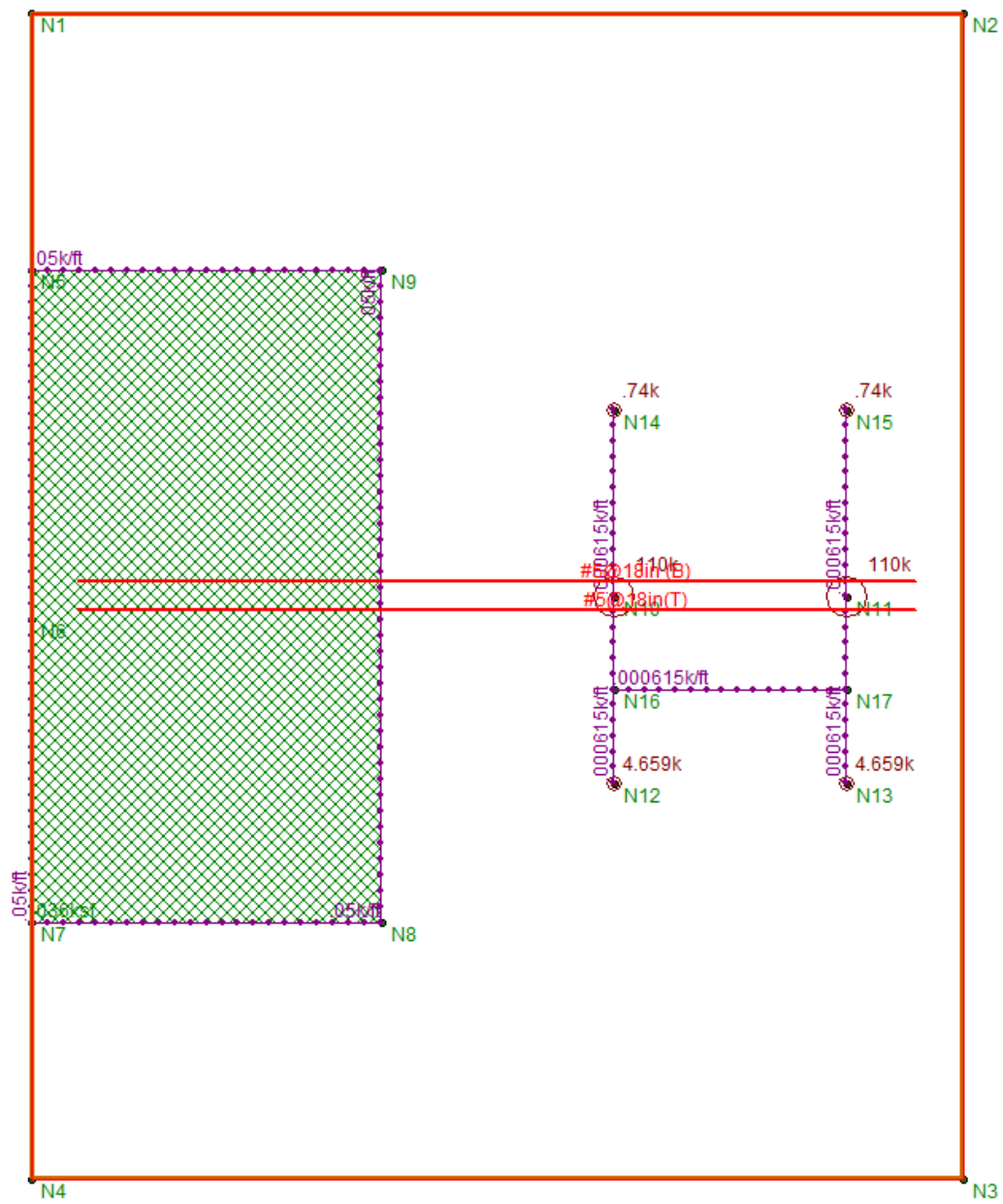
MODULAR CONNECTIONS, LLC 1090 Industrial Blvd Bessemer, AL 35022 Phone: 205-980-4565 Fax: 877-675-5555 Email: info@modularconnections.com		DRAWN BY DH DATE 9-26-17	JOB NO. MCP983-MC4334
TITLE KVA, INC. 16" X 28" X 9'8" IH SHELTER		SCALE NA	PROJ MGR CLP

NOTICE: These drawings and specifications are the property of Modular Connections, LLC. All information contained herein which is not known generally in the field of Modular Connectors, LLC shall be confidential except to any extent to which it is established to have been known previously from sources other than Modular Connections, LLC. These drawings and specifications may not be reproduced, copied or used as the basis for the manufacture or sale of apparatus without written permission.

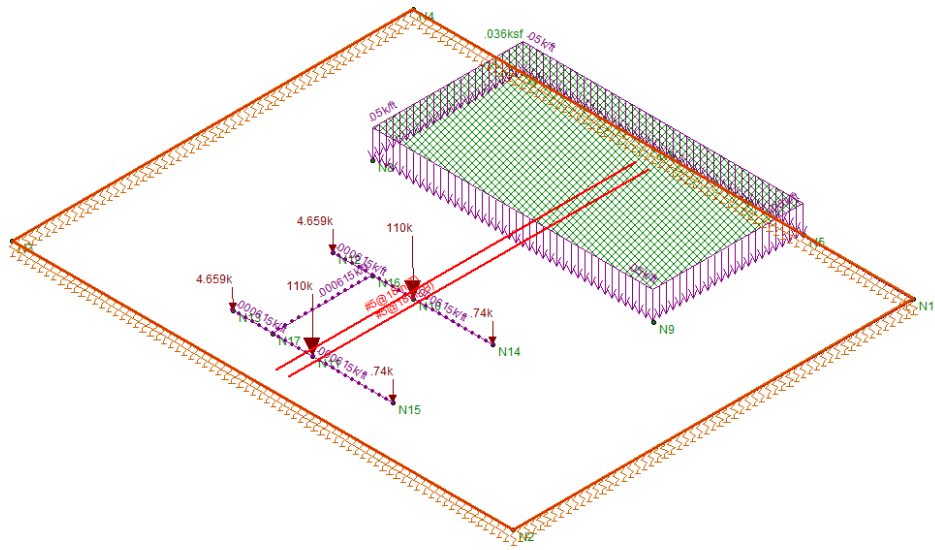
DRAWING NO. D16230 R1

SHEET

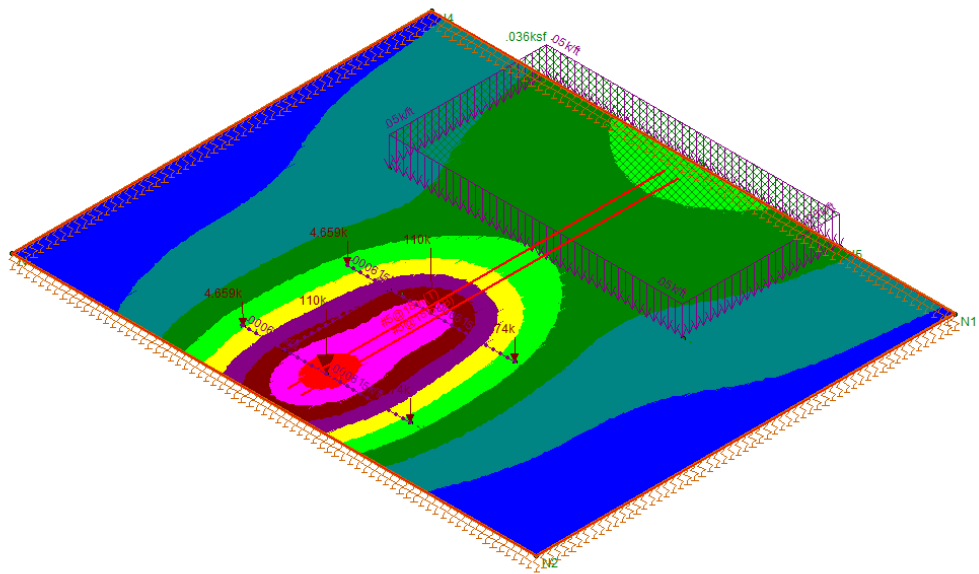
02



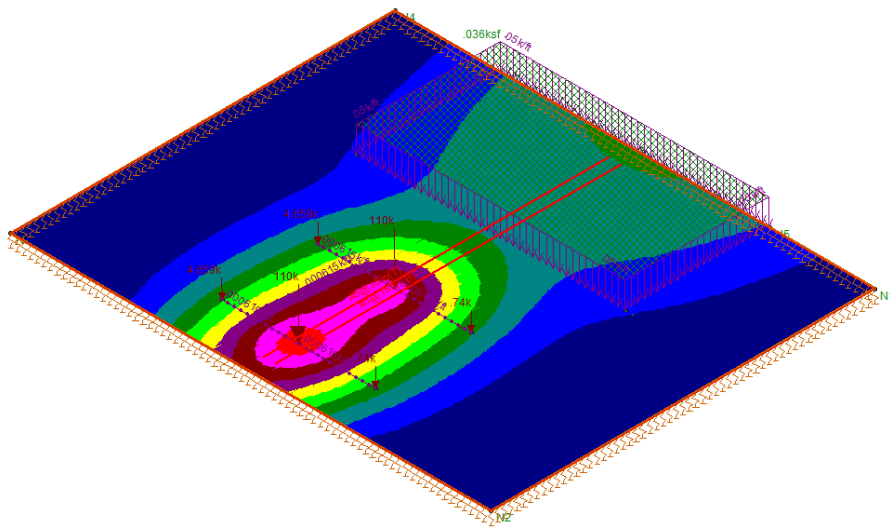
Plan View of Model



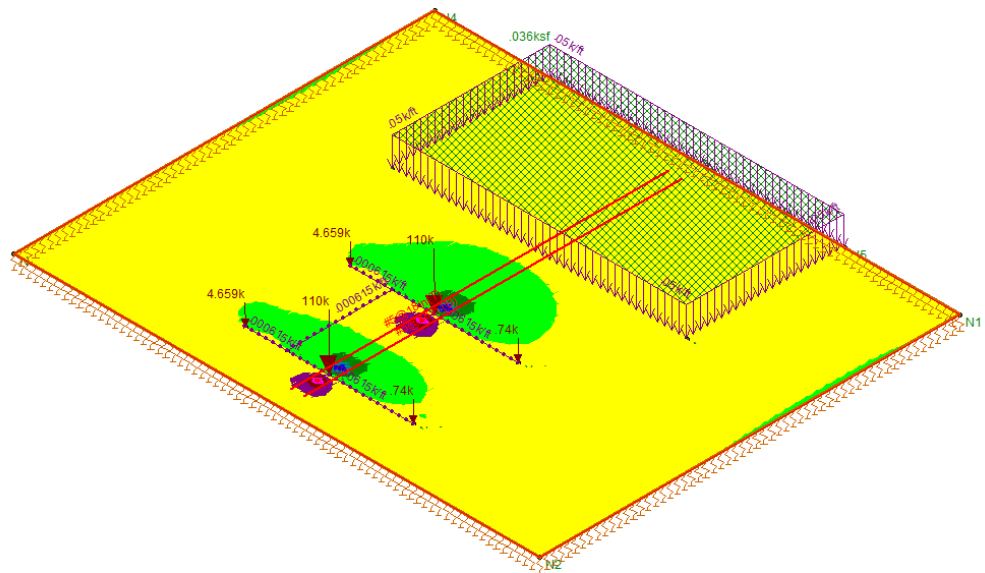
Isometric View of Model



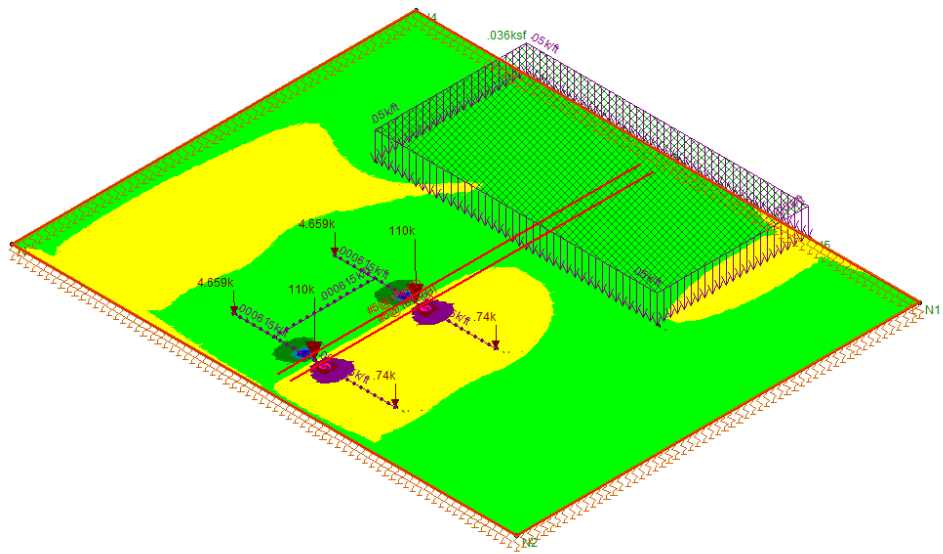
Soil pressure



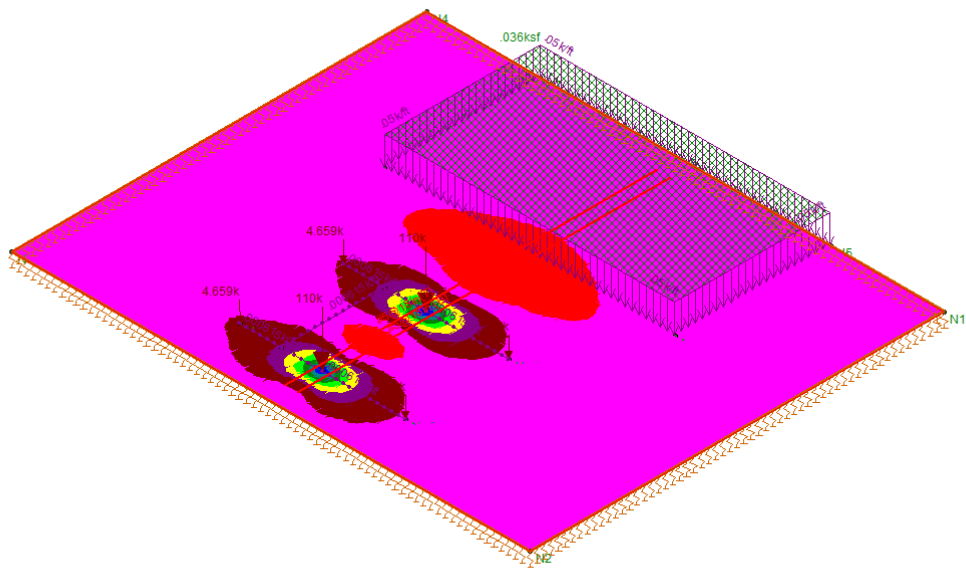
Displacement



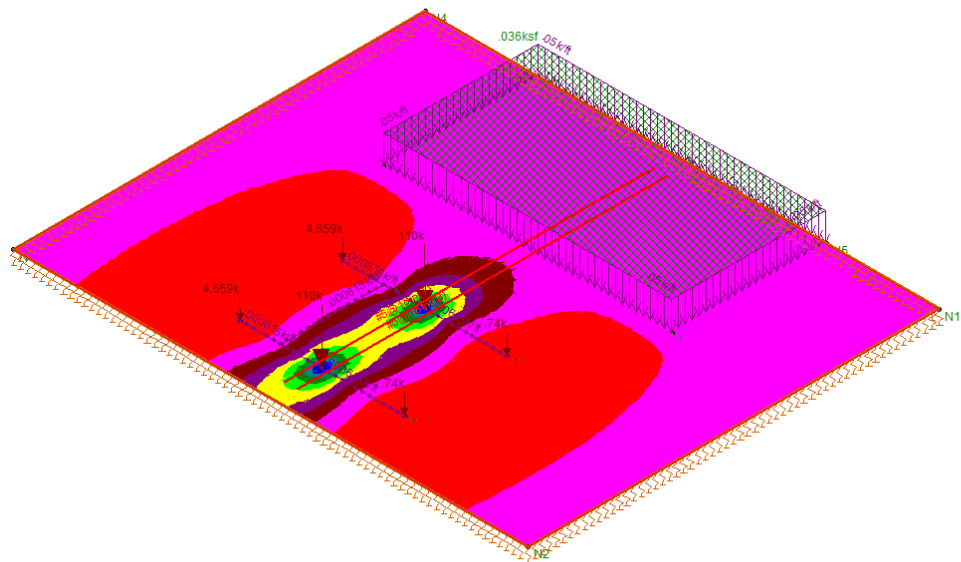
QZ



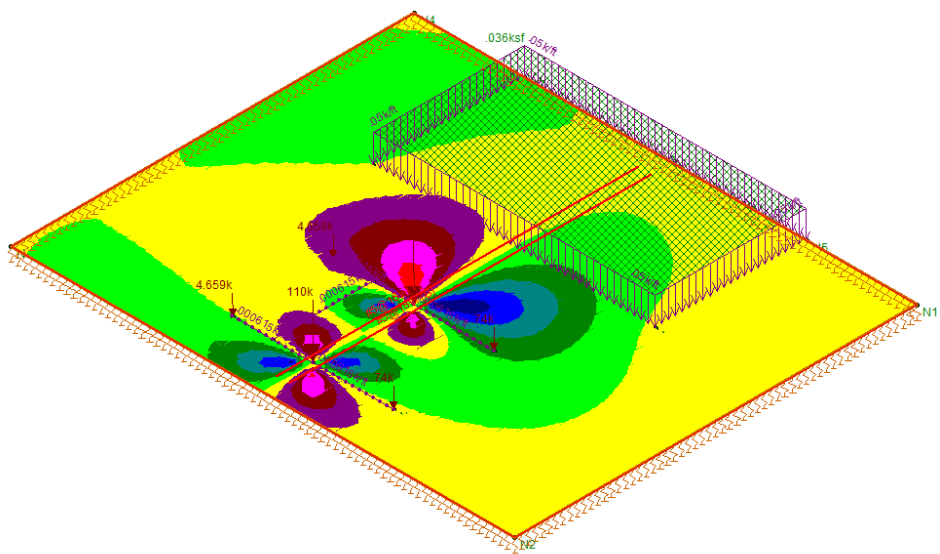
QX



MZ



MX



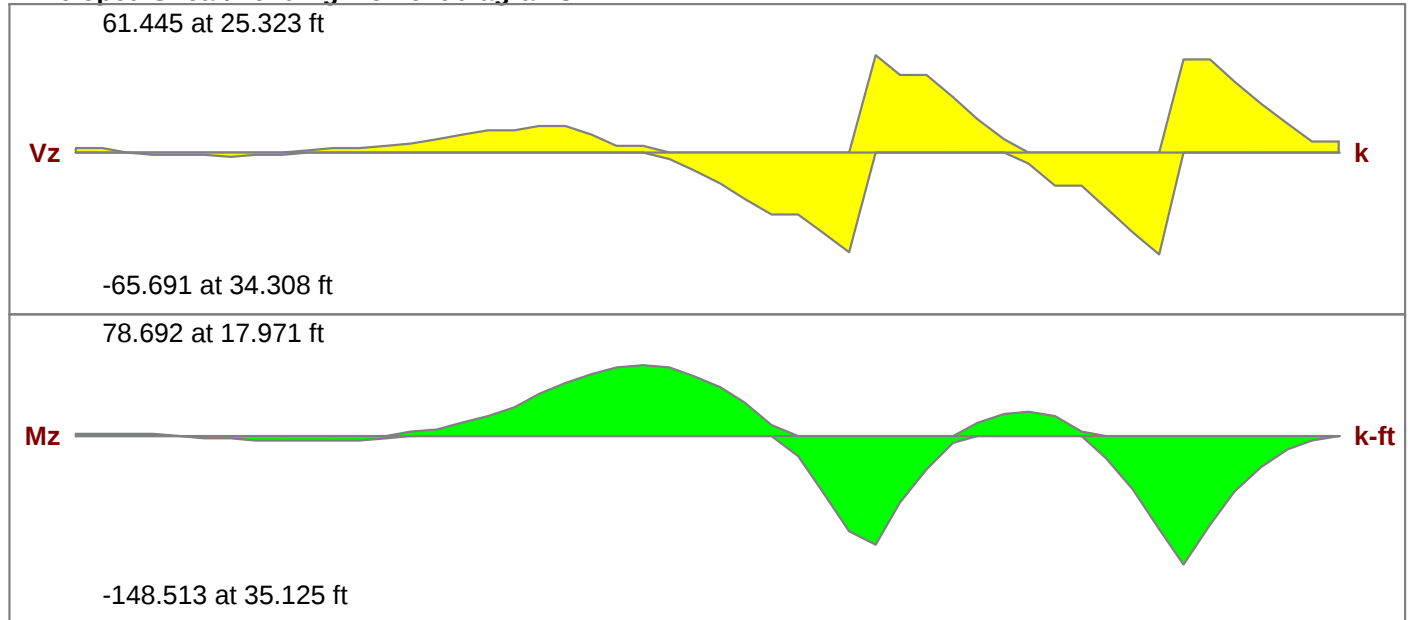
MXZ

Strip: **DS1**
 Material: **Conc3000NW**
 Strip Width: **600.39 in**
 Total Cuts: **50**

Max Top bar Spac.: **18 in**
 Min Top bar Spac.: **3 in**
 Max Bot bar Spac.: **18 in**
 Min Bot bar Spac.: **3 in**

Stress Block: **Rectangular**
 Rebar Orientation: **0**
 Rebar Spacing Inc: **2 in**
 Design Rule: **Typical**

Enveloped Shear/Bending Moment diagrams



ACI 318-11 Code Check

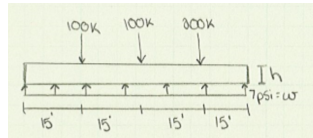
Top Bending Check	0.173	Bot Bending Check	0.326	1 Way Shear Check	0.131
Gov Mu Top	78.692 k-ft	Gov Mu Bot	-148.513 k-ft	Gov Vu	65.691 k
phi*Mn Top	455.096 k-ft	phi*Mn Bot	455.096 k-ft	phi*Vn	502.522 k
Governing Cut	DS1-X23	Governing Cut	DS1-X44	Governing Cut	DS1-X43
Tension Bar Fy	60 ksi	Concrete Weight	.145 k/ft^3	Top Cover	1.5 in
Shear Bar Fy	60 ksi	λ	1	Bottom Cover	1.5 in
F'c	3 ksi	E_Concrete	3156 ksi	Side Cover	3 in
Flex. Rebar Set	ASTM A615	Prvd Bot Bar Spac.	#5@18in	Prvd Top Bar Spac.	#5@18in

Bending Steel Req'd/Prvd, Units: in²)

Cut Label	Top As Req'd	Top As Prvd	Bot As Req'd	Bot As Prvd	Rho Req'd(T/S)	Rho Prvd(Gross)
DS1-X23	1.722	10.124	NA	10.124	0.00180	0.00281
DS1-X44	NA	10.124	3.26	10.124	0.00180	0.00281
DS1-X43	NA	10.124	2.355	10.124	0.00180	0.00281

Structural Calculation

Length (feet)	40
Width (feet)	50
Soil Bearing Capacity (psi)	7
Compressive strength of concrete (f'c) (psi)	3000
Load 1 (k)	110
Load 2 (k)	110
Load 3 (k)	4.659
Load 4 (k)	4.659
Load 5 (k)	0.74
Load 6 (k)	0.74
Height (feet)	1
Weight of Reinforced Concrete (lbs/ft3)	150



Limit States

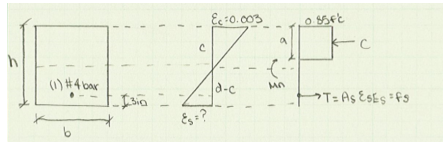
Shear
Flexure
Punching Shear
1-Way Shear

Calculations

Converting soil bearing capacity load (k)	2016
Load of concrete (k)	300
Area of steel (inches ²)	0.2
Compressive strength of steel (psi)	60000
c (inches)	0.0092272203
Height (inches)	3.0153787
d (inches)	0.01
es	0.00025125
φVn	530.798
φMn	65.64705882
a (inches)	0.007843137255

Unrealistically small, will assume larger height for constructability purposes

Does not yield
Less than soil bearing capacity=good



Will compare to Vu and Mu and draw shear and moment diagrams when I receive loading information

$L = 60'$
 $W = 40'$
 $W = 7 \text{ psi}$
 $f'_c = 4000 \text{ psi}$

$\frac{1}{11} \left(\frac{60' \times 12''}{1'} \right) \left(\frac{40' \times 12''}{1'} \right) = 3414.2 \text{ k}$

$\frac{150 \text{ lb}}{\text{ft}^3} (60') (40') (h) = 360(h) \text{ k}$

$\frac{c}{0.003} = \frac{d-c}{0.002}$, $d = h - 3$
 $0.002c = 0.003(h - 3 - c)$
 $0.005c = 0.003h - 0.009$
 $0.005(0.00365) + 0.003h - 0.009$
 $h = 3.01 \text{ in}$
 $\therefore \text{unrealistic}$
 $es = \frac{d-c}{c} (0.001) = \frac{0.01 - 0.00865}{0.00865} (0.003) = 0.000468$
 $\therefore \text{Does not yield}$
 $\therefore \text{Do not need reinforcement}$

$\sum M_{x=0} = 0 \rightarrow 100(15) + 100(30) + 200(45) - (3414.2)(30) + 360h(30) = 0$
 $\rightarrow h = 5.47 \text{ ft} \approx 5.5 \text{ ft}$

$\frac{150 \text{ lb}}{\text{ft}^3} (60') (40') (5.5') = 1980 \text{ k}$

$100 \text{ k} + 100 \text{ k} + 200 \text{ k} + 1980 \text{ k} = 2380 \text{ k} \downarrow ; 3414.2 \text{ k} \downarrow$

$\therefore \text{Design can handle required loads with given allowable soil pressure and an } h = 5.5 \text{ feet.}$

- ITEMS:
1. PROVISION ON BASE FOR SKIDDING
 2. TRANSFORMER LIFTING LUGS
 3. STAINLESS STEEL GROUND PADS (2) ON DIAGONALLY OPPOSITE SIDE OF TANK
 4. STAINLESS STEEL DIAGRAMMATIC NAMEPLATE
 5. 20" DIA. MANHOLE (2) WITH COVER (BOLTED AND GASKETED)
 6. WELDED TOP COVER WITH LIFTING EYES (4) FOR COVER ONLY
 7. COOLING RADIATORS (6), HOT DIPPED GALVANIZED, UNPAINTED, DEMOUNTABLE WITH ISOLATION VALVES, LIFTING EYES, AND 1/2" DRAIN/VENT PLUGS
 8. HV DRAWLEAD BUSHING, 69 kV, 350 kV BIL (3) WITH 4 HOLE NEMA PAD MAKE: ABB TYPE "O+C"
 9. LV BOTTOM CONNECTED BUSHING, 25 kV, 150 kV BIL, (4) WITH 4 HOLE NEMA PAD MAKE: ABB TYPE "O+C"
 10. 2" COMBINATION LOWER DRAIN AND FILTER VALVE WITH SAMPLER AND PLUG
 11. 1" UPPER FILTER VALVE AND PLUG
 12. VTC PRESSURIZATION TEST POINT WITH 1/2" BALL VALVE AND PLUG
 13. LIQUID LEVEL GAUGE WITH CONTACTS, GAUGE CENTER IS AT 25deg C OIL LEVEL
 14. LIQUID TEMPERATURE GAUGE WITH CONTACTS
 15. PRESSURE VACUUM GAUGE, INSIDE NITROGEN BOX, WITH CONTACTS AND BLEEDER
 16. PRESSURE RELIEF DEVICE WITH CONTACTS, FLAG & DIRECTIONAL SHROUD, PIPED DOWN THE SIDE OF THE TRANSFORMER & SUPPORTED USING AN 8" PVC PIPE
 17. DE-ENERGIZED NO LOAD MANUAL TAP CHANGER WITH PROVISION FOR PADLOCKING
 18. CONTROL BOX, NEMA 4, 48 x 60 x 18, WITH BOLTED BOTTOM PLATE
 19. JACK PADS (4) WITH PULLING EYES
 20. BOX FOR CT FEED-THRU'S AND MAIN CORE GROUND BUSHING
 21. COOLING FANS (8)
 22. WINDING TEMPERATURE GAUGE, SIMULATION SYSTEM, WITH CONTACTS
 23. BOLTED, GASKETED PLATE FOR ACCESS TO DETC
 24. THERMOWELLS FOR TEMPERATURE GAUGES & ETM
 25. SUDDEN PRESSURE RELAY WITH SEAL-IN RELAY & SHUT OFF VALVE
 26. HV STATION CLASS ARRESTER, POLYMER, 54 kV, 42 kV MCOV; MAKE: HUBBELL
 27. LV STATION CLASS ARRESTER, POLYMER, 10 kV, 8.4 kV MCOV; MAKE: HUBBELL
 28. POCKET FOR PREVENTIVE AUTO TRANSFORMER
 29. BOX FOR NITROGEN BOTTLE AND TWO STAGE CONTROLS
 30. LOAD TAP CHANGER SWITCH COMPARTMENT, TYPE RMV-II
 31. LTC DE-HYDRATING BREATHER, WITH TUBING AND SHUT OFF VALVE
 32. LTC OIL FILL NIPPLE & CAP, 1"
 33. LTC VACUUM FILLING NIPPLE & CAP, 2"
 34. LTC POSITION INDICATOR WITH DRAG HAND
 35. 2" LTC GLOBE TYPE, BRONZE, DRAIN VALVE WITH 3/8" SAMPLER AND PLUG
 36. LTC HAND CRANK OPERATING LOCATION
 37. LTC LIQUID LEVEL GAUGE WITH CONTACTS
 38. LTC PRESSURE RELIEF DEVICE WITH CONTACTS, FLAG & DIRECTIONAL SHROUD, PIPED DOWN THE SIDE OF THE TRANSFORMER & SUPPORTED USING AN 8" PVC PIPE
 39. FALL PROTECTION MOUNTING PLATE
 40. BOX FOR PA CORE GROUND BUSHING
 41. 1/2" X 3" CU. GROUND BUS FROM X0 BUSHING TO GROUND PAD AT BASE OF XFMR
 42. ELECTRONIC TEMPERATURE MONITOR, INSIDE CONTROL BOX, VISIBLE THRU VIEW GLASS
 43. AMBIENT TEMPERATURE RTD

- NOTES:
1. TYPE II MINERAL OIL FILLED TRANSFORMER, APPROXIMATELY 3975 GALLONS
 2. OUTDOOR SERVICE
 3. PAINT: ANSI-70, ZINC RICH PRIMER, URETHANE OVER EPOXY (VTC PAINT SYSTEM IV), TANK INSIDE AND CORE CLAMPS PAINTED WHITE, BASE UNDERCOATED WITH COAL-TAR EPOXY
 4. TOUCH UP PAINT KIT PROVIDED
 5. UNIT DESIGNED FOR INERT GAS TYPE OIL PRESERVATION
 6. SEE 20 SERIES SHEETS FOR SCHEMATIC
 7. ACCESSORY WIRING IN RIGID GALVANIZED STEEL CONDUIT; FINAL SHORT RUNS MAY BE FLEXIBLE LIQUID TIGHT CONDUIT; FAN POWER VIA WEATHERPROOF CORDS AND PLUGS
 8. CG1 IS FULLY ASSEMBLED, CG2 IS AS SHIPPED
 9. UNIT DESIGNED FOR FULL VACUUM FILLING
 10. UNIT SHIPS WITH FOLLOWING ITEMS DEMOUNTED:
ITEM: SHIPPING WEIGHT:
HV BUSHINGS/ HV PADS 450 LBS
RADIATORS, FANS & FAN BKTS. 9,520 LBS
OIL FOR RADS
(2 DRUMS RAD OIL @ 55 GALLONS = 110 GALLONS) 825 LBS
MAIN UNIT 99,205 LBS
229 GAL OF RAD OIL SHIPS IN GAS SPACE= 5.78" ABOVE 25deg C LEVEL
 11. UNIT DESIGNED FOR OPERATION AT MINIMUM AMBIENT - 20deg C
 12. TANK SEAMS ARE WELDED INSIDE AND OUTSIDE-NO CORNER WELDS WITHIN 8" OF CORNER
 13. UNIT SHIPS WITH IMPACT RECORDER
 14. 60/60 MONTHS EXTENDED WARRANTY IS PROVIDED
 15. CONTRACTED DOCUMENTS SHIP INSIDE CONTROL BOX
 16. SFRA TEST TO BE PERFORMED ON THE UNIT IN FACTORY & AT SITE

Liquid Filled Transformer Data:

MOD/SN: 47015MA156

MVA: 15/20/25 AT 55°C RISE

MVA: 16.8/22.4/28 AT 65°C RISE

3 PHASE, 60 Hz

CLASS: ONAN/ONAF/ONAF

IMP: 7.5 % NOM.

WT: 110,000 LBS

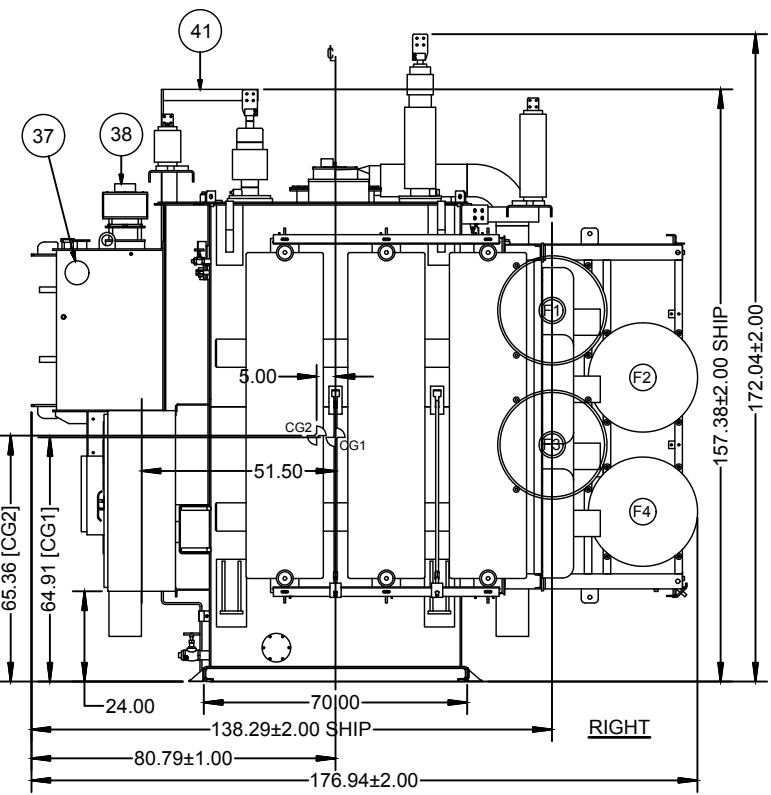
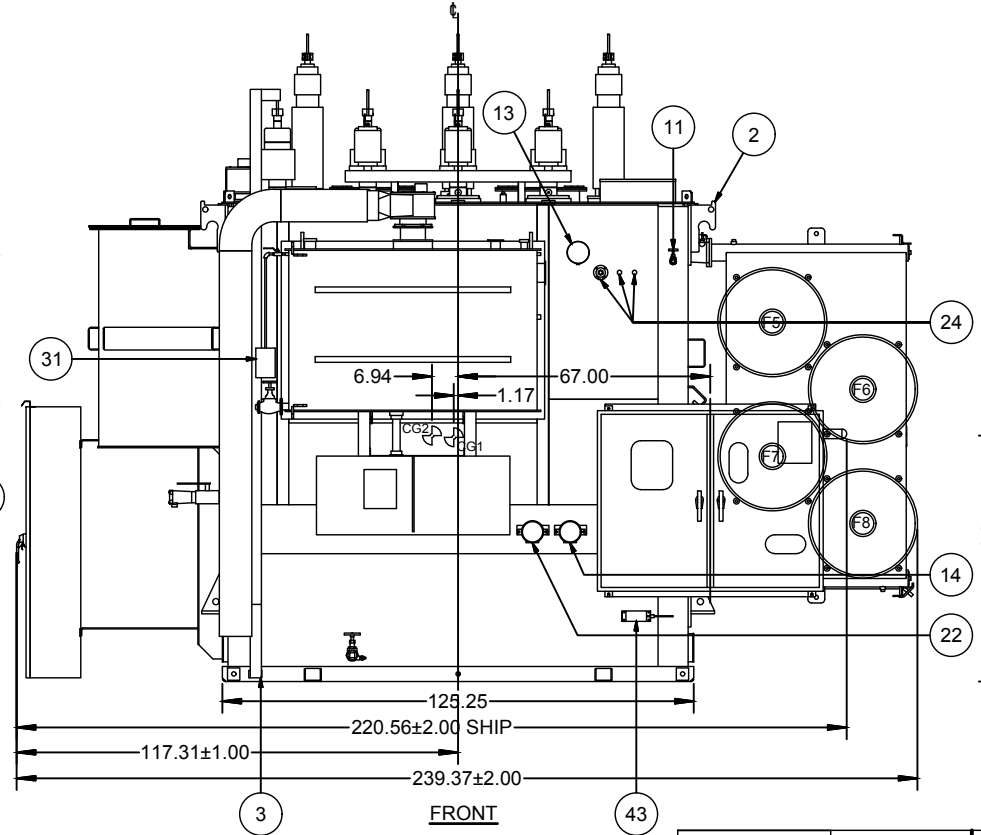
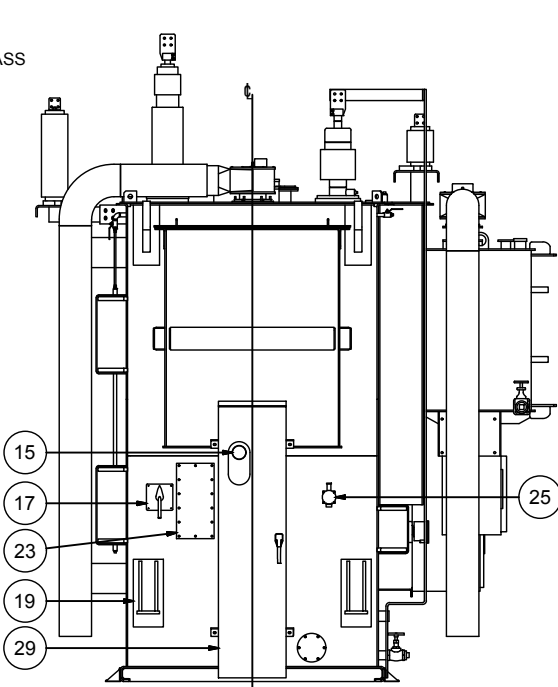
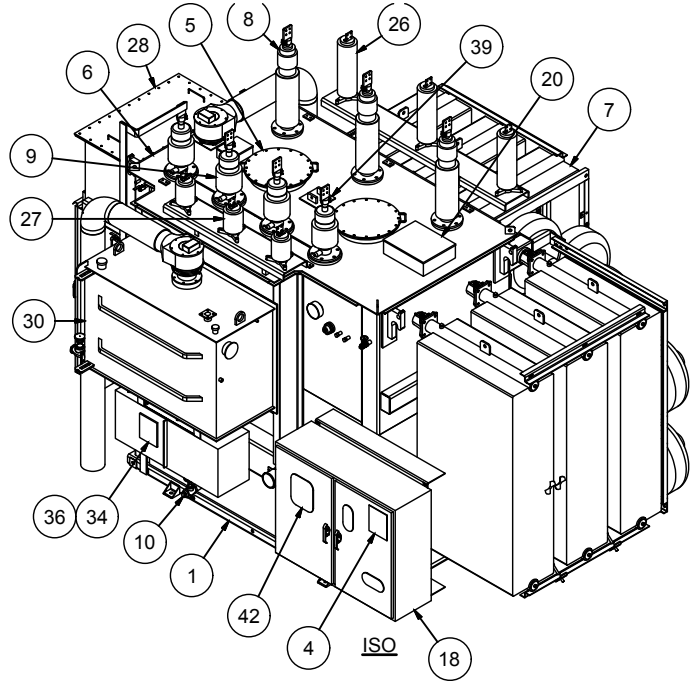
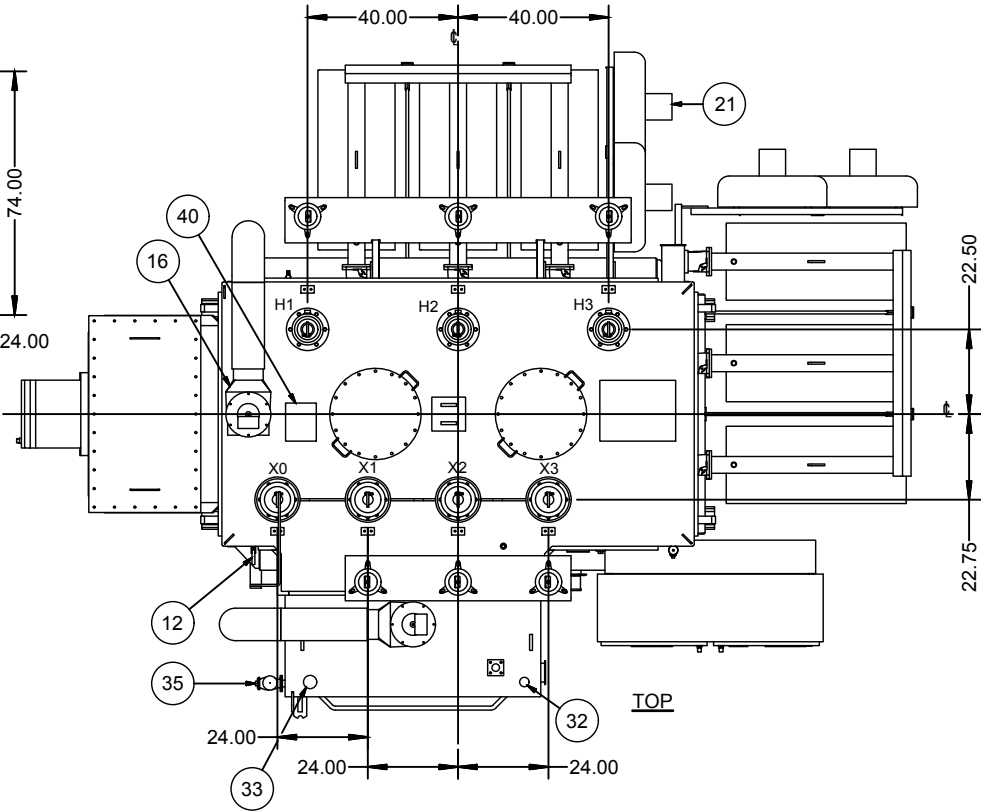
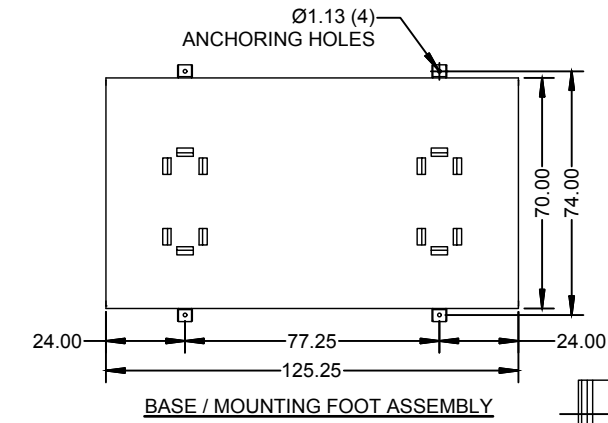
WINDINGS: COPPER

HV DE-ENERGIZED TAPS: ± 2 X 2.616 %

LV LOAD TAPS: ±16 X 0.625%

HV: 68800 V DELTA, 350 kV BIL, 235 A NOM @ 28 MVA

LV: 13090 Y/7558 V, 110 kV BIL, 1235 A @ 28 MVA



Customer: APPALACHIAN ELECTRIC COOPERATIVE
Project: BEAN STATION SUBSTATION

Warranty Field Work:
If, at the job site, the equipment is found to have not conformed to specifications or needs re-work covered under warranty, all parties concerned shall provide full access to Virginia Transformer Corp. or their representatives to work on the unit(s) at the job site. The method of repair/re-work will be determined solely by Virginia Transformer Corp.

TOLERANCES
IF NO TOLERANCES
SHOWN ±0.5(12.7)
OTHERWISE:

Δ ±0.25(6.3)
□ ±1.0(25.4)

ALL DIMENSIONS IN
INCHES & IN mm
IF SHOWN IN
PARENTESIS



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EXCEPT BY WRITTEN
PERMISSION OF VTC.
C796A-101.idw

VIRGINIA TRANSFORMER CORP.
220 GLADE VIEW DR., N.E. ROANOKE, VA 24012
(540) 345-9892

TITLE: DIMENSIONAL OUTLINE JOB # C796A,B

DWN: APK CHK:SKS DATE: 08/11/17

D 47015MA156

SHEET 101 REVISION 0

Appendix B: Geotechnical Data



AEC Substation
Jefferson City, Tennessee
GEOServices Project # 21-19057

LOG OF BORING **B-1**

SHEET 1 OF 2

DRILLER B. Snow

ON-SITE REP. _____

BORING NO. / LOCATION B-1 DRY ON COMPLETION ? Yes

DATE January 31, 2019 SURFACE ELEV. 1252.0 FT.

REFUSAL: No DEPTH _____ FT. ELEV. _____ FT.

SAMPLED 25.0 FT. 7.6 M

TOP OF ROCK DEPTH _____ FT. ELEV. _____ FT.

BEGAN CORING DEPTH _____ FT. ELEV. _____ FT.

FOOTAGE CORED (LF) _____ FT.

BOTTOM OF HOLE DEPTH 25.0 FT. ELEV. 1227.0 FT.

WATER LEVEL DATA (IF APPLICABLE)

COMPLETION: DEPTH DRY FT.

ELEV. _____ FT.

AFTER 1 HRS: DEPTH TNP FT.

ELEV. _____ FT.

AFTER 24 HRS: DEPTH TNP FT.

ELEV. _____ FT.

BORING ADVANCED BY: _____ POWER AUGERING X PROPOSED FFE: _____ FT.

STRATUM		SAMPLE DEPTH		SAMPLE OR RUN NO.	SAMPLE TYPE	FIELD RESULTS		LABORATORY RESULTS			STRATUM DESCRIPTION
DEPTH FT.	ELEV.	FROM FT.	TO FT.			N-Value	Qu	LL	PI	%M	
-											-
-											-
-											-
2.5	1249.5	1.0	2.5	1	SS	4 - 3 - 3 N = 6					-
-											-
-											-
-											-
5.0	1247.0	3.5	5.0	2	SS	4 - 7 - 8 N = 15					-
-											-
-											-
-											-
7.5	1244.5	6.0	7.5	3	SS	5 - 8 - 13 N = 21					-
-											-
-											-
-											-
10.0	1242.0	8.5	10.0	4	SS	6 - 10 - 10 N = 20					-
-											-
-											-
-											-
12.5	1239.5										-
-											-
-											-
-											-
15.0	1237.0	13.5	15.0	5	SS	3 - 5 - 7 N = 12					-
-											-
-											-
-											-
17.5	1234.5										-
-											-
-											-
-											-
20.0	1232.0	18.5	20.0	6	SS	3 - 3 - 4 N = 7					-
											Continued

REMARKS: _____



AEC Substation
Jefferson City, Tennessee
GEOServices Project # 21-19057

LOG OF BORING **B-1**
SHEET 2 OF 2

DRILLER B. Snow
ON-SITE REP. _____

BORING NO. / LOCATION B-1 DRY ON COMPLETION ? Yes

DATE January 31, 2019 SURFACE ELEV. 1252.0 FT.
REFUSAL: No DEPTH _____ FT. ELEV. _____ FT.
SAMPLED 25.0 FT. 7.6 M
TOP OF ROCK DEPTH _____ FT. ELEV. _____ FT.
BEGAN CORING DEPTH _____ FT. ELEV. _____ FT.
FOOTAGE CORED (LF) _____ FT.
BOTTOM OF HOLE DEPTH 25.0 FT. ELEV. 1227.0 FT.

WATER LEVEL DATA (IF APPLICABLE)
COMPLETION: DEPTH DRY FT.
ELEV. _____ FT.
AFTER 1 HRS: DEPTH TNP FT.
ELEV. _____ FT.
AFTER 24 HRS: DEPTH TNP FT.
ELEV. _____ FT.

BORING ADVANCED BY: _____ POWER AUGERING X PROPOSED FFE: _____ FT.

STRATUM DEPTH				SAMPLE DEPTH		SAMPLE OR RUN NO.	SAMPLE TYPE	FIELD RESULTS		LABORATORY RESULTS			STRATUM DESCRIPTION									
				FROM	TO			N-Value	Qu	LL	PI	%M										
FT.	IN	IN	ELEV.	FT.	FT.																	
	-			23.5	25.0	7	SS	3 - 3 - 4 N = 7					(continued)									
22.5	-		1229.5																			Fat CLAY (CH) - with trace chert gravel - orangish brown - moist - stiff to firm (RESIDUUM)
	-																					
	-																					
25.0	-		1227.0																			
	-																					
	-																					
	-																					
27.5	-		1224.5																			
	-																					
	-																					
30.0	-		1222.0																			
	-																					
	-																					
	-																					
32.5	-		1219.5																			
	-																					
	-																					
35.0	-		1217.0																			
	-																					
	-																					
	-																					
37.5	-		1214.5																			
	-																					
	-																					
	-																					
40.0	-		1212.0																			

REMARKS: _____



AEC Substation
Jefferson City, Tennessee
GEOServices Project # 21-19057

LOG OF BORING **B-2**
SHEET 2 OF 2

DRILLER B. Snow
ON-SITE REP. _____

BORING NO. / LOCATION B-2 DRY ON COMPLETION ? Yes

DATE January 31, 2019 SURFACE ELEV. 1250.0 FT.
REFUSAL: No DEPTH _____ FT. ELEV. _____ FT.
SAMPLED 25.0 FT. 7.6 M
TOP OF ROCK DEPTH _____ FT. ELEV. _____ FT.
BEGAN CORING DEPTH _____ FT. ELEV. _____ FT.
FOOTAGE CORED (LF) _____ FT.
BOTTOM OF HOLE DEPTH 25.0 FT. ELEV. 1225.0 FT.

WATER LEVEL DATA (IF APPLICABLE)
COMPLETION: DEPTH DRY FT.
ELEV. _____ FT.
AFTER 1 HRS: DEPTH TNP FT.
ELEV. _____ FT.
AFTER 24 HRS. DEPTH TNP FT.
ELEV. _____ FT.

BORING ADVANCED BY: _____ POWER AUGERING X PROPOSED FFE: _____ FT.

STRATUM				SAMPLE DEPTH		SAMPLE OR RUN NO.	SAMPLE TYPE	FIELD RESULTS		LABORATORY RESULTS			STRATUM DESCRIPTION
DEPTH				FROM	TO			RESULTS		RESULTS			
FT.	IN	IN	ELEV.	FT.	FT.			N-Value	Qu	LL	PI	%M	
-	-	-	-	23.5	25.0	7	SS	3 - 4 - 4 N = 8					(continued)
22.5	-	-	1227.5										Lean CLAY (CL) - with trace root structures in the upper 5' - dark reddish brown and dark brown - moist - stiff to firm (RESIDUUM)
25.0	-	-	1225.0										Boring Terminated at 25.0 Feet
27.5	-	-	1222.5										
30.0	-	-	1220.0										
32.5	-	-	1217.5										
35.0	-	-	1215.0										
37.5	-	-	1212.5										
40.0	-	-	1210.0										

REMARKS: _____



AEC Substation
Jefferson City, Tennessee
GEOServices Project # 21-19057

LOG OF BORING **B-3**
SHEET 2 OF 6

DRILLER B. Snow
ON-SITE REP. _____

BORING NO. / LOCATION B-3 DRY ON COMPLETION ? Yes

DATE January 31, 2019 SURFACE ELEV. 1250.0 FT.
REFUSAL: Yes DEPTH 49.5 FT. ELEV. 1200.5 FT.
SAMPLED 124.5 FT. 37.9 M
TOP OF ROCK DEPTH 49.5 FT. ELEV. 1200.5 FT.
BEGAN CORING DEPTH 49.5 FT. ELEV. 1200.5 FT.
FOOTAGE CORED (LF) 75.0 FT.
BOTTOM OF HOLE DEPTH 124.5 FT. ELEV. 1125.5 FT.

WATER LEVEL DATA (IF APPLICABLE)
COMPLETION: DEPTH DRY FT.
ELEV. _____ FT.
AFTER 1 HRS: DEPTH TNP FT.
ELEV. _____ FT.
AFTER 24 HRS. DEPTH TNP FT.
ELEV. _____ FT.

BORING ADVANCED BY: _____ POWER AUGERING X PROPOSED FFE: _____ FT.

STRATUM				SAMPLE DEPTH		SAMPLE OR RUN NO.	SAMPLE TYPE	FIELD RESULTS		LABORATORY RESULTS			STRATUM DESCRIPTION
DEPTH				FROM	TO			RESULTS		RESULTS			
FT.	IN	IN	ELEV.	FT.	FT.			N-Value	Qu	LL	PI	%M	
	-												(continued)
	-												
	-												
	-												
22.5	-		1227.5										
	-												
	-												
	-												
	-												
	-												
	-												
25.0	-		1225.0	23.5	25.0	7	SS	2 - 3 - 4 N = 7					
	-												
	-												
	-												
	-												
	-												
27.5	-		1222.5										
	-												
	-												
	-												
	-												
	-												
	-												
30.0	-		1220.0	28.5	30.0	8	SS	4 - 5 - 6 N = 11					Lean CLAY (CL) - dark reddish brown and dark brown - moist to wet - firm to very stiff (RESIDUUM)
	-												
	-												
	-												
	-												
32.5	-		1217.5										
	-												
	-												
	-												
	-												
	-												
35.0	-		1215.0	33.5	35.0	9	SS	2 - 3 - 3 N = 6					
	-												
	-												
	-												
	-												
37.5	-		1212.5										
	-												
	-												
	-												
	-												
	-												
40.0	-		1210.0	38.5	40.0	10	SS	3 - 4 - 7 N = 11					
Continued													

REMARKS: _____



AEC Substation
Jefferson City, Tennessee
GEOServices Project # 21-19057

LOG OF BORING **B-3**

SHEET 3 OF 6

DRILLER B. Snow

ON-SITE REP. _____

BORING NO. / LOCATION

B-3

DRY ON COMPLETION ?

Yes

DATE January 31, 2019

SURFACE ELEV. 1250.0 FT.

REFUSAL: Yes DEPTH 49.5 FT.

ELEV. 1200.5 FT.

SAMPLED 124.5 FT. 37.9 M

TOP OF ROCK DEPTH 49.5 FT.

ELEV. 1200.5 FT.

BEGAN CORING DEPTH 49.5 FT.

ELEV. 1200.5 FT.

FOOTAGE CORED (LF) 75.0 FT.

BOTTOM OF HOLE DEPTH 124.5 FT.

ELEV. 1125.5 FT.

WATER LEVEL DATA (IF APPLICABLE)

COMPLETION: DEPTH DRY FT.

ELEV. _____ FT.

AFTER 1 HRS: DEPTH TNP FT.

ELEV. _____ FT.

AFTER 24 HRS: DEPTH TNP FT.

ELEV. _____ FT.

BORING ADVANCED BY:

POWER AUGERING

X

PROPOSED FFE: _____ FT.

STRATUM DEPTH	SAMPLE DEPTH		SAMPLE OR	SAMPLE TYPE	FIELD RESULTS		LABORATORY RESULTS			STRATUM DESCRIPTION
	FROM	TO			N-Value	Qu	LL	PI	%M	
FT.	FT.	FT.	RUN NO.							
42.5										(continued)
45.0	43.5	45.0	11	SS	6 - 7 - 17 N = 24					Lean CLAY (CL) - dark reddish brown and dark brown - moist to wet - firm to very stiff (RESIDUUM)
47.5	48.5	49.6	12	SS	7 - 9 - 50/1" N = 59/7"					Weathered ROCK (WR) - Dolomite - light gray - moist - very hard (RESIDUUM)
50.0	RUN 1	From (ft.) 49.5	To (ft.) 59.5	REC 66%	RQD 65%					Auger Refusal at 49.5 Feet Began Coring at 49.5 Feet DOLOMITE - with healed calcite seams - light gray - moderately fractured and slightly weathered - moderately hard - no discernable dip angle - weak HCl reaction
52.5										VOID (51.9 to 55.3 Feet)
55.0										
57.5										DOLOMITE - with healed calcite seams - light gray - moderately fractured and slightly weathered - moderately hard - no discernable dip angle - weak HCl reaction
60.0										Continued

REMARKS: Black indicates depth of void encountered.



AEC Substation
Jefferson City, Tennessee
GEOServices Project # 21-19057

LOG OF BORING **B-3**
SHEET 4 OF 6

DRILLER B. Snow
ON-SITE REP. _____

BORING NO. / LOCATION B-3 DRY ON COMPLETION ? Yes

DATE January 31, 2019 SURFACE ELEV. 1250.0 FT.
REFUSAL: Yes DEPTH 49.5 FT. ELEV. 1200.5 FT.
SAMPLED 124.5 FT. 37.9 M
TOP OF ROCK DEPTH 49.5 FT. ELEV. 1200.5 FT.
BEGAN CORING DEPTH 49.5 FT. ELEV. 1200.5 FT.
FOOTAGE CORED (LF) 75.0 FT.
BOTTOM OF HOLE DEPTH 124.5 FT. ELEV. 1125.5 FT.

WATER LEVEL DATA (IF APPLICABLE)

COMPLETION: DEPTH DRY FT.
ELEV. _____ FT.
AFTER 1 HRS: DEPTH TNP FT.
ELEV. _____ FT.
AFTER 24 HRS: DEPTH TNP FT.
ELEV. _____ FT.

BORING ADVANCED BY: _____ POWER AUGERING X PROPOSED FFE: _____ FT.

STRATUM DEPTH	SAMPLE DEPTH		SAMPLE OR	SAMPLE TYPE	FIELD RESULTS		LABORATORY RESULTS			STRATUM DESCRIPTION
	FROM	TO			N-Value	Qu	LL	PI	%M	
FT.	FT.	FT.	RUN NO.							
-	RUN 2	From (ft.)	To (ft.)	REC	RQD					(continued)
-		59.5	69.5	100%	91%					
62.5										
-										
65.0										DOLOMITE - with healed calcite seams - light gray - slightly fractured and slightly weathered - moderately hard - no discernable dip angle - weak HCl reaction
67.5										
70.0	RUN 3	From (ft.)	To (ft.)	REC	RQD					
-		69.5	79.5	91%	81%					
72.5										
75.0										DOLOMITE - with healed calcite seams - light gray - slightly to moderately fractured and slightly weathered - moderately hard - no discernable dip angle - weak HCl reaction
77.5										
80.0										
										Continued

REMARKS: _____



AEC Substation
Jefferson City, Tennessee
GEOServices Project # 21-19057

LOG OF BORING **B-3**
SHEET 5 OF 6

DRILLER B. Snow
ON-SITE REP. _____

BORING NO. / LOCATION B-3 DRY ON COMPLETION ? Yes

DATE January 31, 2019 SURFACE ELEV. 1250.0 FT.
REFUSAL: Yes DEPTH 49.5 FT. ELEV. 1200.5 FT.
SAMPLED 124.5 FT. 37.9 M
TOP OF ROCK DEPTH 49.5 FT. ELEV. 1200.5 FT.
BEGAN CORING DEPTH 49.5 FT. ELEV. 1200.5 FT.
FOOTAGE CORED (LF) 75.0 FT.
BOTTOM OF HOLE DEPTH 124.5 FT. ELEV. 1125.5 FT.

WATER LEVEL DATA (IF APPLICABLE)

COMPLETION: DEPTH DRY FT.
ELEV. _____ FT.
AFTER 1 HRS: DEPTH TNP FT.
ELEV. _____ FT.
AFTER 24 HRS: DEPTH TNP FT.
ELEV. _____ FT.

BORING ADVANCED BY: _____ POWER AUGERING X PROPOSED FFE: _____ FT.

STRATUM DEPTH				SAMPLE DEPTH		SAMPLE OR RUN NO.	SAMPLE TYPE	FIELD RESULTS		LABORATORY RESULTS			STRATUM DESCRIPTION
				FROM	TO			RESULTS		RESULTS			
FT.	IN	OUT	ELEV.	FT.	FT.			N-Value	Qu	LL	PI	%M	
-				RUN 4	From (ft.)	To (ft.)	REC	RQD					(continued)
-					79.5	89.5	100%	98%					
82.5			1167.5										
-													
-													
85.0			1165.0										DOLOMITE - with healed calcite seams - light gray - slightly fractured and slightly weathered - moderately hard - no discernable dip angle - weak HCl reaction
-													
-													
87.5			1162.5										
-													
-													
90.0			1160.0	RUN 5	From (ft.)	To (ft.)	REC	RQD					
-					89.5	99.5	98%	75%					
-													
-													
92.5			1157.5										
-													
-													
95.0			1155.0										DOLOMITE - with healed calcite seams - light gray - slightly to moderately fractured and slightly weathered - moderately hard - no discernable dip angle - weak HCl reaction
-													
-													
97.5			1152.5										
-													
-													
100.0			1150.0										
Continued													

REMARKS: _____



AEC Substation
Jefferson City, Tennessee
GEOServices Project # 21-19057

LOG OF BORING **B-3**
SHEET 6 OF 6

DRILLER B. Snow
ON-SITE REP. _____

BORING NO. / LOCATION B-3 DRY ON COMPLETION ? Yes

DATE January 31, 2019 SURFACE ELEV. 1250.0 FT.
REFUSAL: Yes DEPTH 49.5 FT. ELEV. 1200.5 FT.
SAMPLED 124.5 FT. 37.9 M
TOP OF ROCK DEPTH 49.5 FT. ELEV. 1200.5 FT.
BEGAN CORING DEPTH 49.5 FT. ELEV. 1200.5 FT.
FOOTAGE CORED (LF) 75.0 FT.
BOTTOM OF HOLE DEPTH 124.5 FT. ELEV. 1125.5 FT.

WATER LEVEL DATA (IF APPLICABLE)

COMPLETION: DEPTH DRY FT.
ELEV. _____ FT.
AFTER 1 HRS: DEPTH TNP FT.
ELEV. _____ FT.
AFTER 24 HRS: DEPTH TNP FT.
ELEV. _____ FT.

BORING ADVANCED BY: _____ POWER AUGERING X PROPOSED FFE: _____ FT.

STRATUM DEPTH	SAMPLE DEPTH		SAMPLE OR	SAMPLE TYPE	FIELD RESULTS		LABORATORY RESULTS			STRATUM DESCRIPTION
	FROM	TO			N-Value	Qu	LL	PI	%M	
FT.	FT.	FT.	RUN NO.							
-	RUN 6	From (ft.)	To (ft.)	REC	RQD					(continued)
-		99.5	109.5	90%	63%					
-										
102.5 - 1147.5										DOLOMITE - light gray - slightly to moderately fractured and slightly weathered - moderately hard - no discernable dip angle - weak HCl reaction
-										
-	RUN 7	From (ft.)	To (ft.)	REC	RQD					VOID (104.0 to 105.0 Feet)
105.0 - 1145.0		109.5	124.5	90%	81%					
-										
107.5 - 1142.5										DOLOMITE - light gray - slightly to moderately fractured and slightly weathered - moderately hard - no discernable dip angle - weak HCl reaction
-										
-		From (ft.)	To (ft.)	REC	RQD					
110.0 - 1140.0		109.5	124.5	90%	81%					
-										
112.5 - 1137.5										
-										
-		From (ft.)	To (ft.)	REC	RQD					
115.0 - 1135.0		109.5	124.5	90%	81%					
-										
117.5 - 1132.5										
-										
120.0 - 1130.0										

Coring Terminated at 124.5 Feet

REMARKS: Black indicates depth of void encountered.



AEC Substation
Jefferson City, Tennessee
GEOServices Project # 21-19057

LOG OF BORING **B-4**

SHEET 1 OF 4

DRILLER B. Snow

ON-SITE REP. _____

BORING NO. / LOCATION

B-4

DRY ON COMPLETION ?

No

DATE February 4, 2019 SURFACE ELEV. 1248.0 FT.
REFUSAL: Yes DEPTH 68.0 FT. ELEV. 1180.0 FT.
SAMPLED 78.3 FT. 23.9 M
TOP OF ROCK DEPTH 68.0 FT. ELEV. 1180.0 FT.
BEGAN CORING DEPTH 68.0 FT. ELEV. 1180.0 FT.
FOOTAGE CORED (LF) 10.3 FT.
BOTTOM OF HOLE DEPTH 78.3 FT. ELEV. 1169.7 FT.

WATER LEVEL DATA (IF APPLICABLE)

COMPLETION: DEPTH 59.0 FT.
ELEV. 1189.0 FT.
AFTER 1 HRS: DEPTH TNP FT.
ELEV. _____ FT.
AFTER 24 HRS: DEPTH TNP FT.
ELEV. _____ FT.

BORING ADVANCED BY:

POWER AUGERING

X

PROPOSED FFE: _____ FT.

STRATUM DEPTH	SAMPLE DEPTH		SAMPLE OR	SAMPLE TYPE	FIELD RESULTS		LABORATORY RESULTS			STRATUM DESCRIPTION
	FROM	TO			N-Value	Qu	LL	PI	%M	
FT.	FT.	FT.	RUN NO.							
—										Topsoil (10 Inches)
2.5 — 1245.5	1.0	2.5	1	SS	2 - 3 - 2 N = 5					
5.0 — 1243.0	3.5	5.0	2	SS	5 - 5 - 6 N = 11					
7.5 — 1240.5	6.0	7.5	3	SS	4 - 7 - 6 N = 13					
10.0 — 1238.0	8.5	10.0	4	SS	5 - 9 - 12 N = 21					
12.5 — 1235.5										
15.0 — 1233.0	13.5	15.0	5	SS	6 - 9 - 9 N = 18					
17.5 — 1230.5										
20.0 — 1228.0	18.5	20.0	6	SS	6 - 6 - 8 N = 14					
										Continued

REMARKS: _____



AEC Substation
Jefferson City, Tennessee
GEOServices Project # 21-19057

LOG OF BORING **B-4**
SHEET 2 OF 4

DRILLER B. Snow
ON-SITE REP. _____

BORING NO. / LOCATION B-4 DRY ON COMPLETION ? No

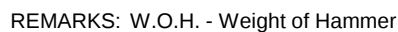
DATE February 4, 2019 SURFACE ELEV. 1248.0 FT.
REFUSAL: Yes DEPTH 68.0 FT. ELEV. 1180.0 FT.
SAMPLED 78.3 FT. 23.9 M
TOP OF ROCK DEPTH 68.0 FT. ELEV. 1180.0 FT.
BEGAN CORING DEPTH 68.0 FT. ELEV. 1180.0 FT.
FOOTAGE CORED (LF) 10.3 FT.
BOTTOM OF HOLE DEPTH 78.3 FT. ELEV. 1169.7 FT.

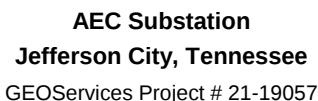
WATER LEVEL DATA (IF APPLICABLE)
COMPLETION: DEPTH 59.0 FT.
ELEV. 1189.0 FT.
AFTER 1 HRS: DEPTH TNP FT.
ELEV. _____ FT.
AFTER 24 HRS. DEPTH TNP FT.
ELEV. _____ FT.

BORING ADVANCED BY: _____ POWER AUGERING X PROPOSED FFE: _____ FT.

STRATUM DEPTH	SAMPLE DEPTH		SAMPLE OR	SAMPLE TYPE	FIELD RESULTS		LABORATORY RESULTS			STRATUM DESCRIPTION
	FROM	TO			N-Value	Qu	LL	PI	%M	
FT.	FT.	FT.	RUN NO.							
22.5 - 1225.5										(continued)
25.0 - 1223.0	23.5	25.0	7	SS	2 - 3 - 3 N = 6					Fat CLAY (CH) - with trace root structures in the upper 5' - reddish brown, dark reddish brown and orangish brown - moist - very stiff to firm (RESIDUUM)
27.5 - 1220.5										
30.0 - 1218.0	28.5	30.0	8	SS	3 - 4 - 3 N = 7					
32.5 - 1215.5										
35.0 - 1213.0	33.5	35.0	9	SS	2 - 3 - 2 N = 5					Lean CLAY (CL) - orangish brown and light brown - moist to wet - very soft to firm (RESIDUUM)
37.5 - 1210.5										
40.0 - 1208.0	38.5	40.0	10	SS	3 - 2 - 3 N = 5					
										Continued

REMARKS: _____





SHEET 4 OF 4

ON-SITE REP.

B-4

DRY ON COMPLETION ?

No

DATE	February 4, 2019	SURFACE ELEV.	1248.0	FT.
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REFUSAL:	Yes	DEPTH	68.0	FT.	ELEV.	1180.0	FT.
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SAMPLED	78.3 FT.	23.9 M
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TOP OF ROCK	DEPTH	68.0	FT.	ELEV.	1180.0	FT.
-------------	-------	------	-----	-------	--------	-----

BEGAN CORING	DEPTH	68.0	FT.	ELEV.	1180.0	FT.
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FOOTAGE CORED (LF)	10.3 FT.
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BOTTOM OF HOLE	DEPTH	78.3	FT.	ELEV.	1169.7	FT.
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WATER LEVEL DATA (IF APPLICABLE)

COMPLETION: DEPTH 59.0 FT.

ELEV. 1189.0 FT.

AFTER 1 HRS:	DEPTH	TNP	FT.
--------------	-------	-----	-----

ELEV. FT.

AFTER 24 HRS.	DEPTH	TNP	FT.
1	10	10	10
2	20	20	20
3	30	30	30
4	40	40	40
5	50	50	50
6	60	60	60
7	70	70	70
8	80	80	80
9	90	90	90
10	100	100	100
11	110	110	110
12	120	120	120
13	130	130	130
14	140	140	140
15	150	150	150
16	160	160	160
17	170	170	170
18	180	180	180
19	190	190	190
20	200	200	200
21	210	210	210
22	220	220	220
23	230	230	230
24	240	240	240
25	250	250	250
26	260	260	260
27	270	270	270
28	280	280	280
29	290	290	290
30	300	300	300
31	310	310	310
32	320	320	320
33	330	330	330
34	340	340	340
35	350	350	350
36	360	360	360
37	370	370	370
38	380	380	380
39	390	390	390
40	400	400	400
41	410	410	410
42	420	420	420
43	430	430	430
44	440	440	440
45	450	450	450
46	460	460	460
47	470	470	470
48	480	480	480
49	490	490	490
50	500	500	500
51	510	510	510
52	520	520	520
53	530	530	530
54	540	540	540
55	550	550	550
56	560	560	560
57	570	570	570
58	580	580	580
59	590	590	590
60	600	600	600
61	610	610	610
62	620	620	620
63	630	630	630
64	640	640	640
65	650	650	650
66	660	660	660
67	670	670	670
68	680	680	680
69	690	690	690
70	700	700	700
71	710	710	710
72	720	720	720
73	730	730	730
74	740	740	740
75	750	750	750
76	760	760	760
77	770	770	770
78	780	780	780
79	790	790	790
80	800	800	800
81	810	810	810
82	820	820	820
83	830	830	830
84	840	840	840
85	850	850	850
86	860	860	860
87	870	870	870
88	880	880	880
89	890	890	890
90	900	900	900
91	910	910	910
92	920	920	920
93	930	930	930
94	940	940	940
95	950	950	950
96	960	960	960
97	970	970	970

ELEV. FT.

BORING ADVANCED BY: POWER AUGERING X

PROPOSED FFE: FT.

REMARKS:



AEC Substation
Jefferson City, Tennessee
GEOServices Project # 21-19057

LOG OF BORING **B-5**
SHEET 1 OF 2

DRILLER B. Snow
ON-SITE REP. _____

BORING NO. / LOCATION B-5 DRY ON COMPLETION ? Yes

DATE January 31, 2019 SURFACE ELEV. 1248.0 FT.
REFUSAL: No DEPTH _____ FT. ELEV. _____ FT.
SAMPLED 25.0 FT. 7.6 M
TOP OF ROCK DEPTH _____ FT. ELEV. _____ FT.
BEGAN CORING DEPTH _____ FT. ELEV. _____ FT.
FOOTAGE CORED (LF) _____ FT.
BOTTOM OF HOLE DEPTH 25.0 FT. ELEV. 1223.0 FT.

WATER LEVEL DATA (IF APPLICABLE)
COMPLETION: DEPTH DRY FT.
ELEV. _____ FT.
AFTER 1 HRS: DEPTH TNP FT.
ELEV. _____ FT.
AFTER 24 HRS: DEPTH TNP FT.
ELEV. _____ FT.

BORING ADVANCED BY: _____ POWER AUGERING X PROPOSED FFE: _____ FT.

STRATUM		SAMPLE DEPTH		SAMPLE OR RUN NO.	SAMPLE TYPE	FIELD RESULTS		LABORATORY RESULTS			STRATUM DESCRIPTION
DEPTH		FROM	TO			N-Value	Qu	LL	PI	%M	
FT.	ELEV.	FT.	FT.								
-											- Topsoil / Gravel (12 Inches)
2.5	1245.5	1.0	2.5	1	SS	5 - 7 - 8 N = 15					-
5.0	1243.0	3.5	5.0	2	SS	3 - 5 - 6 N = 11					- Fat CLAY (CH) - with trace chert gravel - orangish brown and reddish brown - moist - stiff to very stiff (RESIDUUM)
7.5	1240.5	6.0	7.5	3	SS	5 - 6 - 8 N = 14					-
10.0	1238.0	8.5	10.0	4	SS	5 - 8 - 8 N = 16					-
12.5	1235.5										-
15.0	1233.0	13.5	15.0	5	SS	5 - 6 - 8 N = 14					- Lean CLAY (CL) - with chert gravel at depth - orangish brown and reddish brown - moist - stiff (RESIDUUM)
17.5	1230.5										-
20.0	1228.0	18.5	20.0	6	SS	3 - 4 - 6 N = 10					-
											Continued

REMARKS: _____



AEC Substation
Jefferson City, Tennessee
GEOServices Project # 21-19057

LOG OF BORING **B-5**
SHEET 2 OF 2

DRILLER B. Snow
ON-SITE REP. _____

BORING NO. / LOCATION B-5 DRY ON COMPLETION ? Yes

DATE January 31, 2019 SURFACE ELEV. 1248.0 FT.
REFUSAL: No DEPTH _____ FT. ELEV. _____ FT.
SAMPLED 25.0 FT. 7.6 M
TOP OF ROCK DEPTH _____ FT. ELEV. _____ FT.
BEGAN CORING DEPTH _____ FT. ELEV. _____ FT.
FOOTAGE CORED (LF) _____ FT.
BOTTOM OF HOLE DEPTH 25.0 FT. ELEV. 1223.0 FT.

WATER LEVEL DATA (IF APPLICABLE)
COMPLETION: DEPTH DRY FT.
ELEV. _____ FT.
AFTER 1 HRS: DEPTH TNP FT.
ELEV. _____ FT.
AFTER 24 HRS. DEPTH TNP FT.
ELEV. _____ FT.

BORING ADVANCED BY: _____ POWER AUGERING X PROPOSED FFE: _____ FT.

STRATUM DEPTH				SAMPLE DEPTH		SAMPLE OR RUN NO.	SAMPLE TYPE	FIELD RESULTS		LABORATORY RESULTS			STRATUM DESCRIPTION
				FROM	TO								
FT.	IN	IN	ELEV.	FT.	FT.			N-Value	Qu	LL	PI	%M	
	-			23.5	25.0	7	SS	5 - 7 - 8 N = 15					(continued)
22.5	-		1225.5										Lean CLAY (CL) - with chert gravel at depth - orangish brown and reddish brown - moist - stiff (RESIDUUM)
	-												
	-												
25.0	-		1223.0										
	-												
	-												
27.5	-		1220.5										
	-												
	-												
30.0	-		1218.0										
	-												
	-												
32.5	-		1215.5										
	-												
	-												
35.0	-		1213.0										
	-												
	-												
37.5	-		1210.5										
	-												
	-												
40.0	-		1208.0										
Boring Terminated at 25.0 Feet													

REMARKS: _____





AEC Substation
Jefferson City, Tennessee
GEOServices Project # 21-19057

LOG OF BORING **B-6**
SHEET 2 OF 2

DRILLER B. Snow
ON-SITE REP. _____

BORING NO. / LOCATION B-6 DRY ON COMPLETION ? Yes

DATE January 31, 2019 SURFACE ELEV. 1248.0 FT.
REFUSAL: No DEPTH _____ FT. ELEV. _____ FT.
SAMPLED 25.0 FT. 7.6 M
TOP OF ROCK DEPTH _____ FT. ELEV. _____ FT.
BEGAN CORING DEPTH _____ FT. ELEV. _____ FT.
FOOTAGE CORED (LF) _____ FT.
BOTTOM OF HOLE DEPTH 25.0 FT. ELEV. 1223.0 FT.

WATER LEVEL DATA (IF APPLICABLE)
COMPLETION: DEPTH DRY FT.
ELEV. _____ FT.
AFTER 1 HRS: DEPTH TNP FT.
ELEV. _____ FT.
AFTER 24 HRS: DEPTH TNP FT.
ELEV. _____ FT.

BORING ADVANCED BY: _____ POWER AUGERING X PROPOSED FFE: _____ FT.

STRATUM DEPTH				SAMPLE DEPTH		SAMPLE OR RUN NO.	SAMPLE TYPE	FIELD RESULTS		LABORATORY RESULTS			STRATUM DESCRIPTION
				FROM	TO			RESULTS		RESULTS			
FT.			ELEV.	FT.	FT.			N-Value	Qu	LL	PI	%M	
-	-	-	-	23.5	25.0	7	SS	2 - 3 - 3 N = 6					(continued)
22.5	-	-	1225.5										
-	-	-	-										
-	-	-	-										
25.0	-	-	1223.0										
-	-	-	-										
-	-	-	-										
27.5	-	-	1220.5										
-	-	-	-										
-	-	-	-										
30.0	-	-	1218.0										
-	-	-	-										
-	-	-	-										
32.5	-	-	1215.5										
-	-	-	-										
-	-	-	-										
35.0	-	-	1213.0										
-	-	-	-										
-	-	-	-										
37.5	-	-	1210.5										
-	-	-	-										
-	-	-	-										
40.0	-	-	1208.0										
Boring Terminated at 25.0 Feet													

REMARKS: _____





AEC Substation
Jefferson City, Tennessee
GEOServices Project # 21-19057

LOG OF BORING **B-7**
SHEET 2 OF 2

DRILLER B. Snow
ON-SITE REP. _____

BORING NO. / LOCATION B-7 DRY ON COMPLETION ? Yes

DATE January 31, 2019 SURFACE ELEV. 1248.0 FT.
REFUSAL: No DEPTH _____ FT. ELEV. _____ FT.
SAMPLED 35.0 FT. 10.7 M
TOP OF ROCK DEPTH _____ FT. ELEV. _____ FT.
BEGAN CORING DEPTH _____ FT. ELEV. _____ FT.
FOOTAGE CORED (LF) _____ FT.
BOTTOM OF HOLE DEPTH 35.0 FT. ELEV. 1213.0 FT.

WATER LEVEL DATA (IF APPLICABLE)
COMPLETION: DEPTH DRY FT.
ELEV. _____ FT.
AFTER 1 HRS: DEPTH TNP FT.
ELEV. _____ FT.
AFTER 24 HRS: DEPTH TNP FT.
ELEV. _____ FT.

BORING ADVANCED BY: _____ POWER AUGERING X PROPOSED FFE: _____ FT.

STRATUM		SAMPLE DEPTH		SAMPLE OR RUN NO.	SAMPLE TYPE	FIELD RESULTS		LABORATORY RESULTS			STRATUM DESCRIPTION
DEPTH		FROM	TO			N-Value	Qu	LL	PI	%M	
FT.	ELEV.	FT.	FT.								
22.5	1225.5										(continued)
25.0	1223.0	23.5	25.0	7	SS	1 - 2 - 2 N = 4					
27.5	1220.5										
30.0	1218.0	28.5	30.0	8	SS	4 - 3 - 5 N = 8					
32.5	1215.5										
35.0	1213.0	33.5	35.0	9	SS	3 - 3 - 3 N = 6					
37.5	1210.5										
40.0	1208.0										
Boring Terminated at 35.0 Feet											

REMARKS: _____



AEC Substation
Jefferson City, Tennessee
GEOServices Project # 21-19057

LOG OF BORING **B-8**
SHEET 1 OF 2

DRILLER B. Snow
ON-SITE REP. _____

BORING NO. / LOCATION B-8 DRY ON COMPLETION ? Yes

DATE February 1, 2019 SURFACE ELEV. 1244.0 FT.
REFUSAL: No DEPTH _____ FT. ELEV. _____ FT.
SAMPLED 25.0 FT. 7.6 M
TOP OF ROCK DEPTH _____ FT. ELEV. _____ FT.
BEGAN CORING DEPTH _____ FT. ELEV. _____ FT.
FOOTAGE CORED (LF) _____ FT.
BOTTOM OF HOLE DEPTH 25.0 FT. ELEV. 1219.0 FT.

WATER LEVEL DATA (IF APPLICABLE)
COMPLETION: DEPTH DRY FT.
ELEV. _____ FT.
AFTER 1 HRS: DEPTH TNP FT.
ELEV. _____ FT.
AFTER 24 HRS: DEPTH TNP FT.
ELEV. _____ FT.

BORING ADVANCED BY: _____ POWER AUGERING X PROPOSED FFE: _____ FT.

STRATUM		SAMPLE DEPTH		SAMPLE OR RUN NO.	SAMPLE TYPE	FIELD RESULTS		LABORATORY RESULTS			STRATUM DESCRIPTION
DEPTH		FROM	TO			N-Value	Qu	LL	PI	%M	
FT.	ELEV.	FT.	FT.								
-											-
-											-
-											-
2.5	1241.5	1.0	2.5	1	SS	1 - 2 - 3 N = 5					-
-											-
-											-
-											-
5.0	1239.0	3.5	5.0	2	SS	1 - 2 - 2 N = 4					-
-											-
-											-
7.5	1236.5	6.0	7.5	3	SS	1 - 2 - 3 N = 5					-
-											-
-											-
10.0	1234.0	8.5	10.0	4	SS	5 - 8 - 9 N = 17					-
-											-
-											-
12.5	1231.5										-
-											-
-											-
15.0	1229.0	13.5	15.0	5	SS	3 - 5 - 6 N = 11					-
-											-
-											-
17.5	1226.5										-
-											-
-											-
20.0	1224.0	18.5	20.0	6	SS	1 - 3 - 3 N = 6					-
											Continued

REMARKS: _____



AEC Substation
Jefferson City, Tennessee
GEOServices Project # 21-19057

LOG OF BORING **B-8**
SHEET 2 OF 2

DRILLER B. Snow
ON-SITE REP. _____

BORING NO. / LOCATION B-8 DRY ON COMPLETION ? Yes

DATE February 1, 2019 SURFACE ELEV. 1244.0 FT.
REFUSAL: No DEPTH _____ FT. ELEV. _____ FT.
SAMPLED 25.0 FT. 7.6 M
TOP OF ROCK DEPTH _____ FT. ELEV. _____ FT.
BEGAN CORING DEPTH _____ FT. ELEV. _____ FT.
FOOTAGE CORED (LF) _____ FT.
BOTTOM OF HOLE DEPTH 25.0 FT. ELEV. 1219.0 FT.

WATER LEVEL DATA (IF APPLICABLE)
COMPLETION: DEPTH DRY FT.
ELEV. _____ FT.
AFTER 1 HRS: DEPTH TNP FT.
ELEV. _____ FT.
AFTER 24 HRS. DEPTH TNP FT.
ELEV. _____ FT.

BORING ADVANCED BY: _____ POWER AUGERING X PROPOSED FFE: _____ FT.

STRATUM		SAMPLE DEPTH		SAMPLE OR RUN NO.	SAMPLE TYPE	FIELD RESULTS		LABORATORY RESULTS			STRATUM DESCRIPTION
DEPTH		FROM	TO			N-Value	Qu	LL	PI	%M	
FT.	ELEV.	FT.	FT.								
-											(continued)
22.5	1221.5										
		23.5	25.0	7	SS	2 - 3 - 4 N = 7					Fat CLAY (CH) - with trace root structures in the upper 2' - orangish brown and reddish brown - moist - very stiff to firm (RESIDUUM)
25.0	1219.0										Boring Terminated at 25.0 Feet
27.5	1216.5										
30.0	1214.0										
32.5	1211.5										
35.0	1209.0										
37.5	1206.5										
40.0	1204.0										

REMARKS: _____



AEC Substation
Jefferson City, Tennessee
GEOServices Project # 21-19057

LOG OF BORING **B-9**
SHEET 1 OF 2

DRILLER B. Snow
ON-SITE REP. _____

BORING NO. / LOCATION B-9 DRY ON COMPLETION ? No

DATE February 1, 2019 SURFACE ELEV. 1242.0 FT.
REFUSAL: No DEPTH _____ FT. ELEV. _____ FT.
SAMPLED 35.0 FT. 10.7 M
TOP OF ROCK DEPTH _____ FT. ELEV. _____ FT.
BEGAN CORING DEPTH _____ FT. ELEV. _____ FT.
FOOTAGE CORED (LF) _____ FT.
BOTTOM OF HOLE DEPTH 35.0 FT. ELEV. 1207.0 FT.

WATER LEVEL DATA (IF APPLICABLE)
COMPLETION: DEPTH 27.0 FT.
ELEV. 1215.0 FT.
AFTER 1 HRS: DEPTH TNP FT.
ELEV. _____ FT.
AFTER 24 HRS. DEPTH TNP FT.
ELEV. _____ FT.

BORING ADVANCED BY: _____ POWER AUGERING X PROPOSED FFE: _____ FT.

STRATUM DEPTH	SAMPLE DEPTH		SAMPLE OR	SAMPLE TYPE	FIELD RESULTS		LABORATORY RESULTS			STRATUM DESCRIPTION
	FROM	TO			N-Value	Qu	LL	PI	%M	
FT.	FT.	FT.	RUN NO.							
-										-
-										-
-										-
2.5 - 1239.5	1.0	2.5	1	SS	1 - 2 - 2 N = 4					-
-										-
-										-
5.0 - 1237.0	3.5	5.0	2	SS	4 - 5 - 4 N = 9					-
-										-
-										-
7.5 - 1234.5	6.0	7.5	3	SS	3 - 4 - 6 N = 10					-
-										-
-										-
10.0 - 1232.0	8.5	10.0	4	SS	6 - 8 - 9 N = 17					-
-										-
-										-
12.5 - 1229.5										-
-										-
-										-
15.0 - 1227.0	13.5	15.0	5	SS	3 - 4 - 4 N = 8					-
-										-
-										-
17.5 - 1224.5										-
-										-
-										-
20.0 - 1222.0	18.5	20.0	6	SS	2 - 2 - 3 N = 5					-
										Continued

REMARKS: _____



AEC Substation
Jefferson City, Tennessee
GEOServices Project # 21-19057

LOG OF BORING **B-9**
SHEET 2 OF 2

DRILLER B. Snow
ON-SITE REP. _____

BORING NO. / LOCATION B-9 DRY ON COMPLETION ? No

DATE February 1, 2019 SURFACE ELEV. 1242.0 FT.
REFUSAL: No DEPTH _____ FT. ELEV. _____ FT.
SAMPLED 35.0 FT. 10.7 M
TOP OF ROCK DEPTH _____ FT. ELEV. _____ FT.
BEGAN CORING DEPTH _____ FT. ELEV. _____ FT.
FOOTAGE CORED (LF) _____ FT.
BOTTOM OF HOLE DEPTH 35.0 FT. ELEV. 1207.0 FT.

WATER LEVEL DATA (IF APPLICABLE)
COMPLETION: DEPTH 27.0 FT.
ELEV. 1215.0 FT.
AFTER 1 HRS: DEPTH TNP FT.
ELEV. _____ FT.
AFTER 24 HRS. DEPTH TNP FT.
ELEV. _____ FT.

BORING ADVANCED BY: _____ POWER AUGERING X PROPOSED FFE: _____ FT.

STRATUM		SAMPLE DEPTH		SAMPLE OR RUN NO.	SAMPLE TYPE	FIELD RESULTS		LABORATORY RESULTS			STRATUM DESCRIPTION
DEPTH		FROM	TO			N-Value	Qu	LL	PI	%M	
FT.	ELEV.	FT.	FT.								
22.5	1219.5	23.5	25.0	7	SS	2 - 3 - 2 N = 5					Lean CLAY (CL) - orangish brown and dark reddish brown - moist - firm to very soft (RESIDUUM)
25.0	1217.0										
27.5	1214.5	28.5	30.0	8	SS	1 - 1 - 1 N = 2					
30.0	1212.0										
32.5	1209.5	33.5	35.0	9	SS	2 - 2 - 2 N = 4					
35.0	1207.0										
37.5	1204.5										
40.0	1202.0										
Boring Terminated at 35.0 Feet											

REMARKS: _____



AEC Substation
Jefferson City, Tennessee
GEOServices Project # 21-19057

LOG OF BORING **B-10**
SHEET 1 OF 2

DRILLER B. Snow
ON-SITE REP. _____

BORING NO. / LOCATION B-10 DRY ON COMPLETION ? Yes

DATE January 31, 2019 SURFACE ELEV. 1254.0 FT.
REFUSAL: No DEPTH _____ FT. ELEV. _____ FT.
SAMPLED 25.0 FT. 7.6 M
TOP OF ROCK DEPTH _____ FT. ELEV. _____ FT.
BEGAN CORING DEPTH _____ FT. ELEV. _____ FT.
FOOTAGE CORED (LF) _____ FT.
BOTTOM OF HOLE DEPTH 25.0 FT. ELEV. 1229.0 FT.

WATER LEVEL DATA (IF APPLICABLE)
COMPLETION: DEPTH DRY FT.
ELEV. _____ FT.
AFTER 1 HRS: DEPTH TNP FT.
ELEV. _____ FT.
AFTER 24 HRS: DEPTH TNP FT.
ELEV. _____ FT.

BORING ADVANCED BY: _____ POWER AUGERING X PROPOSED FFE: _____ FT.

STRATUM		SAMPLE DEPTH		SAMPLE OR RUN NO.	SAMPLE TYPE	FIELD RESULTS		LABORATORY RESULTS			STRATUM DESCRIPTION
DEPTH FT.	ELEV.	FROM FT.	TO FT.			N-Value	Qu	LL	PI	%M	
-											Topsoil (4 Inches)
2.5	1251.5	1.0	2.5	1	SS	3 - 4 - 5 N = 9					
5.0	1249.0	3.5	5.0	2	SS	4 - 5 - 7 N = 12					
7.5	1246.5	6.0	7.5	3	SS	5 - 8 - 9 N = 17					
10.0	1244.0	8.5	10.0	4	SS	4 - 7 - 9 N = 16					Fat CLAY (CH) - with trace chert gravel at depth - reddish brown and orangish brown - moist - stiff to very stiff (RESIDUUM)
12.5	1241.5										
15.0	1239.0	13.5	15.0	5	SS	3 - 5 - 7 N = 12					
17.5	1236.5										
20.0	1234.0	18.5	20.0	6	SS	4 - 5 - 6 N = 11					
Continued											

REMARKS: _____



AEC Substation
Jefferson City, Tennessee
GEOServices Project # 21-19057

LOG OF BORING **B-10**
SHEET 2 OF 2

DRILLER B. Snow
ON-SITE REP. _____

BORING NO. / LOCATION B-10 DRY ON COMPLETION ? Yes

DATE January 31, 2019 SURFACE ELEV. 1254.0 FT.
REFUSAL: No DEPTH _____ FT. ELEV. _____ FT.
SAMPLED 25.0 FT. 7.6 M
TOP OF ROCK DEPTH _____ FT. ELEV. _____ FT.
BEGAN CORING DEPTH _____ FT. ELEV. _____ FT.
FOOTAGE CORED (LF) _____ FT.
BOTTOM OF HOLE DEPTH 25.0 FT. ELEV. 1229.0 FT.

WATER LEVEL DATA (IF APPLICABLE)
COMPLETION: DEPTH DRY FT.
ELEV. _____ FT.
AFTER 1 HRS: DEPTH TNP FT.
ELEV. _____ FT.
AFTER 24 HRS: DEPTH TNP FT.
ELEV. _____ FT.

BORING ADVANCED BY: _____ POWER AUGERING X PROPOSED FFE: _____ FT.

STRATUM		SAMPLE DEPTH		SAMPLE OR RUN NO.	SAMPLE TYPE	FIELD RESULTS		LABORATORY RESULTS			STRATUM DESCRIPTION
DEPTH FT.	ELEV.	FROM FT.	TO FT.			N-Value	Qu	LL	PI	%M	
22.5	1231.5	23.5	25.0	7	SS	3 - 5 - 7 N = 12					(continued)
25.0	1229.0										Fat CLAY (CH) - with trace chert gravel at depth - reddish brown and orangish brown - moist - stiff to very stiff (RESIDUUM) Boring Terminated at 25.0 Feet
27.5	1226.5										
30.0	1224.0										
32.5	1221.5										
35.0	1219.0										
37.5	1216.5										
40.0	1214.0										

REMARKS: _____

Appendix B

Geotech Section

Sample Calculations

• Bearing Capacity of Mat Foundation

AssumptionsUndrained condition $\rightarrow \phi' = 0$ Given $PI = 50 \rightarrow$ From graphical correlation in Skempton's Method

$$\Rightarrow s_u / \sigma'_p = 0.29$$

$$\sigma'_p = (110 \text{ lb/ft}^3)(50 \text{ ft}) = \cancel{1600 \text{ lb/ft}^2} \quad 5500 \text{ lb/ft}^2$$

$$s_u = 1600 \text{ lb/ft}^2 = c \text{ due to undrained condition}$$

Vesic Method Spreadsheet $FS = 3 \rightarrow$ Jefferson County Regulations

$$q_{allowable} = 3,271 \text{ lb/ft}^2$$

$$P_{allowable} = 6,541 \text{ K}$$

BEARING CAPACITY OF SHALLOW FOUNDATIONS

Terzaghi and Vesic Methods

Date April 15, 2019

Identification

Input

Units of Measurement

E SI or E

Foundation Information

Shape RE SQ, CI, CO, or RE

B = 40 ft

L = 50 ft

D = 1.5 ft

Soil Information

c = 1600 lb/ft²

phi = 0 deg

gamma = 110 lb/ft³

Dw = 120 ft

Factor of Safety

F = 3

Results

Terzaghi

Bearing Capacity

q ult = n/a lb/ft²

q a = n/a lb/ft²

Allowable Column Load

P = #VALUE! k

Vesic

9,812 lb/ft²

3,271 lb/ft²

6,541 k

Unit conveyance = 1000

Gamma w = 62.4

phi (radian) = 0

Terzaghi Computations

a theta = 1

Nc = 5.70

Nq = 1.00

N gamma = 0.00

gamma' = 110

coefficient = 0

coefficient = 0

sigma zD' = 165

Vesic Computation

Nc = 5.14

sc = 1.16

dc = 1.02

Nq = 1.00

sq = 1.00

dq = 1.00

N gamma = 0.00

s gamma = 0.68

d gamma = 1.00

B/L = 0.8

k = 0.0375

W sub f = 0

SETTLEMENT ANALYSIS OF SHALLOW FOUNDATIONS

Schertmann Method

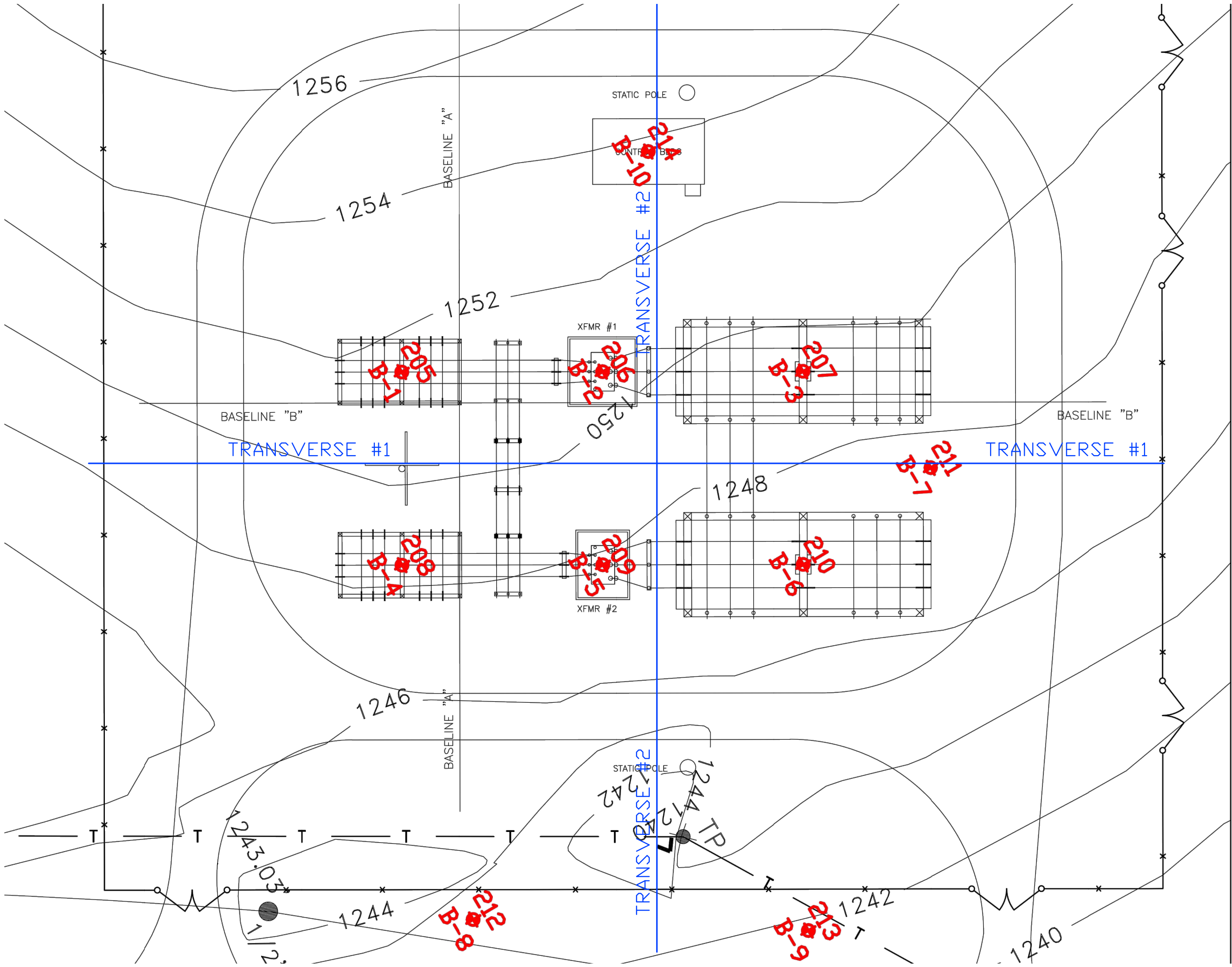
Date April 15, 2019

Identification Example 7.6

Input	Units	E or SI	Results
Shape		RE SQ, CI, CO, or RE	q = 565 lb/ft ² delta = 0.94 in
B =		40 ft	
L =		50 ft	
D =		2.5 ft	
P =		380 k	
Dw =		120 ft	
gamma =		141 lb/ft ³	
t =		50 yr	

Depth to Soil Layer		Es (lb/ft ²)	zf (ft)	I epsilon	strain ()	delta (in)
Top (ft)	Bottom (ft)					
0.0	2.5					
2.5	3.5	4902	0.5	0.113	0.1280	0.0154
3.5	4.5	4902	1.5	0.134	0.1516	0.0182
4.5	5.5	4902	2.5	0.155	0.1753	0.0210
5.5	6.5	4902	3.5	0.176	0.1989	0.0239
6.5	7.5	4902	4.5	0.197	0.2226	0.0267
7.5	8.5	7353	5.5	0.218	0.1642	0.0197
8.5	9.5	7353	6.5	0.239	0.1799	0.0216
9.5	10.5	7353	7.5	0.260	0.1957	0.0235
10.5	11.5	7353	8.5	0.281	0.2115	0.0254
11.5	12.5	7353	9.5	0.302	0.2273	0.0273
12.5	13.5	7353	10.5	0.323	0.2430	0.0292
13.5	14.5	7353	11.5	0.344	0.2588	0.0311
14.5	15.5	7353	12.5	0.364	0.2746	0.0329
15.5	16.5	7353	13.5	0.385	0.2903	0.0348
16.5	17.5	7353	14.5	0.406	0.3061	0.0367
17.5	18.5	10049	15.5	0.427	0.2355	0.0283
18.5	19.5	10049	16.5	0.448	0.2471	0.0296
19.5	20.5	10049	17.5	0.469	0.2586	0.0310
20.5	21.5	10049	18.5	0.490	0.2702	0.0324
21.5	22.5	10049	19.5	0.511	0.2817	0.0338
22.5	23.5	16667	20.5	0.518	0.1720	0.0206
23.5	24.5	16667	21.5	0.509	0.1693	0.0203
24.5	25.5	16667	22.5	0.501	0.1665	0.0200
25.5	26.5	16667	23.5	0.493	0.1638	0.0197
26.5	27.5	16667	24.5	0.484	0.1610	0.0193
27.5	28.5	22059	25.5	0.476	0.1196	0.0143
28.5	29.5	22059	26.5	0.468	0.1175	0.0141
29.5	30.5	22059	27.5	0.459	0.1154	0.0138
30.5	31.5	22059	28.5	0.451	0.1133	0.0136
31.5	32.5	22059	29.5	0.443	0.1112	0.0133
32.5	33.5	14216	30.5	0.435	0.1694	0.0203
33.5	34.5	14216	31.5	0.426	0.1661	0.0199
34.5	35.5	14216	32.5	0.418	0.1629	0.0195
35.5	36.5	14216	33.5	0.410	0.1597	0.0192
36.5	37.5	14216	34.5	0.401	0.1564	0.0188
37.5	38.5	26471	35.5	0.393	0.0823	0.0099
38.5	39.5	26471	36.5	0.385	0.0805	0.0097
39.5	40.5	26471	37.5	0.377	0.0788	0.0095
40.5	41.5	26471	38.5	0.368	0.0771	0.0092
41.5	42.5	26471	39.5	0.360	0.0753	0.0090
42.5	43.5	26471	40.5	0.351	0.0736	0.0088
43.5	44.5	26471	41.5	0.343	0.0717	0.0086

44.5	45.5	26471	42.5	0.334	0.0699	0.0084
45.5	46.5	26471	43.5	0.325	0.0681	0.0082
46.5	47.5	26471	44.5	0.317	0.0663	0.0080
47.5	48.5	26471	45.5	0.308	0.0645	0.0077
48.5	49.5	26471	46.5	0.300	0.0627	0.0075
49.5	50.5	26471	47.5	0.291	0.0609	0.0073
50.5	51.5	26471	48.5	0.282	0.0591	0.0071
51.5	52.5	26471	49.5	0.274	0.0573	0.0069
52.5	53.5	386000	50.5	0.265	0.0038	0.0005
53.5	54.5	386000	51.5	0.256	0.0037	0.0004
54.5	55.5	386000	52.5	0.248	0.0036	0.0004
55.5	56.5	386000	53.5	0.239	0.0034	0.0004
56.5	57.5	386000	54.5	0.230	0.0033	0.0004
57.5	58.5	386000	55.5	0.222	0.0032	0.0004
58.5	59.5	386000	56.5	0.213	0.0031	0.0004
59.5	60.5	386000	57.5	0.204	0.0029	0.0004
60.5	61.5	386000	58.5	0.196	0.0028	0.0003
61.5	62.5	386000	59.5	0.187	0.0027	0.0003
62.5	63.5	386000	60.5	0.178	0.0026	0.0003
63.5	64.5	386000	61.5	0.170	0.0024	0.0003
64.5	65.5	386000	62.5	0.161	0.0023	0.0003
65.5	66.5	386000	63.5	0.153	0.0022	0.0003
66.5	67.5	386000	64.5	0.144	0.0021	0.0002
67.5	68.5	386000	65.5	0.135	0.0019	0.0002
68.5	69.5	386000	66.5	0.127	0.0018	0.0002
69.5	70.5	386000	67.5	0.118	0.0017	0.0002
70.5	71.5	386000	68.5	0.109	0.0016	0.0002
71.5	72.5	386000	69.5	0.101	0.0014	0.0002
72.5	73.5	386000	70.5	0.092	0.0013	0.0002
73.5	74.5	386000	71.5	0.083	0.0012	0.0001
74.5	75.5	386000	72.5	0.075	0.0011	0.0001
75.5	76.5	386000	73.5	0.066	0.0009	0.0001
76.5	77.5	386000	74.5	0.057	0.0008	0.0001
77.5	78.5	386000	75.5	0.049	0.0007	0.0001
78.5	79.5	386000	76.5	0.040	0.0006	0.0001
79.5	80.5	386000	77.5	0.031	0.0005	0.0001
80.5	81.5	386000	78.5	0.023	0.0003	0.0000
81.5	82.5	386000	79.5	0.014	0.0002	0.0000
82.5	83.5	386000	80.5	0.010	0.0001	0.0000
83.5	84.5	386000	81.5	0.010	0.0001	0.0000
84.5	85.5	386000	82.5	0.010	0.0001	0.0000
85.5	86.5	386000	83.5	0.009	0.0001	0.0000
86.5	87.5	386000	84.5	0.009	0.0001	0.0000
87.5	88.5	386000	85.5	0.009	0.0001	0.0000
88.5	89.5	386000	86.5	0.009	0.0001	0.0000
89.5	90.5	386000	87.5	0.009	0.0001	0.0000
90.5	91.5	386000	88.5	0.009	0.0001	0.0000
91.5	92.5	386000	89.5	0.009	0.0001	0.0000
92.5	93.5	386000	90.5	0.009	0.0001	0.0000
93.5	94.5	386000	91.5	0.008	0.0001	0.0000
94.5	95.5	386000	92.5	0.008	0.0001	0.0000
95.5	96.5	386000	93.5	0.008	0.0001	0.0000
96.5	97.5	386000	94.5	0.008	0.0001	0.0000
97.5	98.5	386000	95.5	0.008	0.0001	0.0000
98.5	99.5	386000	96.5	0.008	0.0001	0.0000
99.5	100.5	386000	97.5	0.008	0.0001	0.0000
100.5	101.5	386000	98.5	0.008	0.0001	0.0000
101.5	102.5	386000	99.5	0.007	0.0001	0.0000
102.5	103.5	386000	100.5	0.007	0.0001	0.0000
103.5	104.5	386000	101.5	0.007	0.0001	0.0000
104.5	105.5	386000	102.5	0.007	0.0001	0.0000
105.5	106.5	386000	103.5	0.007	0.0001	0.0000
106.5	107.5	386000	104.5	0.007	0.0001	0.0000
107.5	108.5	386000	105.5	0.007	0.0001	0.0000



NOTES:

- 1.) BORING LOCATIONS ARE SHOWN IN GENERAL ARRANGEMENT ONLY.
- 2.) DO NOT USE BORING LOCATIONS FOR DETERMINATIONS OF DISTANCES OR QUANTITIES.
- 3.) BASE MAP PROVIDED BY: C2RL, INC.

**SOIL TEST BORING
AND TRANSVERSE LINE
LOCATION PLAN**

PROPOSED AEC SUBSTATION
JEFFERSON CITY, TENNESSEE

DRAWN BY:	MTB
APPROVED BY:	MBH
SCALE:	N.T.S.
JOB NO.:	21-19057
DATE:	2-12-2019

GEOS
Geotechnical and Earthquake Engineering
2561 Willow Point Way
Knoxville, Tennessee 37931
Office: 865-539-8242
Fax: 865-539-8252

Figure 2



Bean Station
Knoxville, Tennessee
GEOServices Project # 21-16438

LOG OF BORING **B-1**

SHEET 1 OF 1

DRILLER Fred Reynolds

ON-SITE REP. _____

BORING NO. / LOCATION

B-1

DRY ON COMPLETION ?

Yes

DATE July 8, 2016

SURFACE ELEV. 1108.0 FT.

REFUSAL: Yes DEPTH 9.1 FT.

ELEV. 1098.9 FT.

SAMPLED 9.1 FT. 2.8 M

TOP OF ROCK DEPTH _____ FT.

ELEV. _____ FT.

BEGAN CORING DEPTH _____ FT.

ELEV. _____ FT.

FOOTAGE CORED (LF) _____ FT.

BOTTOM OF HOLE DEPTH _____ FT.

ELEV. 1108.0 FT.

BORING ADVANCED BY:

POWER AUGERING

X

WATER LEVEL DATA (IF APPLICABLE)

COMPLETION: DEPTH Dry FT.

ELEV. _____ FT.

AFTER 1 HRS: DEPTH TNP FT.

ELEV. _____ FT.

AFTER 24 HRS: DEPTH TNP FT.

ELEV. _____ FT.

PROPOSED FFE: _____ FT.

STRATUM DEPTH	SAMPLE DEPTH		SAMPLE OR RUN NO.	SAMPLE TYPE	FIELD RESULTS		LABORATORY RESULTS			STRATUM DESCRIPTION
	FROM	TO			N-Value	Qu	LL	PI	%M	
FT.	FT.	FT.								
2.5	1.0	2.5	1	SS	28					Lean CLAY - with silt and trace root structure - orangish brown and gray - moist - very stiff to very hard (RESIDUUM)
5.0	3.5	5.0	2	SS	74					Weathered Shale - gray - dry - very hard
7.5	6.0	6.7	3	SS	50/2"					
10.0	8.5	8.6	4	SS	50/1"					Auger Refusal at 9.1 feet
12.5										
15.0										
17.5										
20.0										

REMARKS: _____



Bean Station
Knoxville, Tennessee
GEOServices Project # 21-16438

LOG OF BORING **B-2**

SHEET 1 OF 1

DRILLER Fred Reynolds

ON-SITE REP.

BORING NO. / LOCATION

B-2

DRY ON COMPLETION ?

Yes

DATE July 8, 2016

SURFACE ELEV. 1105.0 FT.

REFUSAL: Yes DEPTH 6.0 FT.

ELEV. 1100.0 FT.

SAMPLED 6.0 FT. 1.8 M

TOP OF ROCK DEPTH FT.

ELEV. FT.

BEGAN CORING DEPTH FT.

ELEV. FT.

FOOTAGE CORED (LF) FT.

BOTTOM OF HOLE DEPTH 6.0 FT.

ELEV. 1100.0 FT.

BORING ADVANCED BY:

POWER AUGERING

X

WATER LEVEL DATA (IF APPLICABLE)

COMPLETION: DEPTH Dry FT.

ELEV. FT.

AFTER 1 HRS: DEPTH Dry FT.

ELEV. FT.

AFTER 24 HRS: DEPTH TNP FT.

ELEV. FT.

PROPOSED FFE: FT.

STRATUM				SAMPLE DEPTH		SAMPLE	SAMPLE TYPE	FIELD RESULTS		LABORATORY RESULTS			STRATUM DESCRIPTION	
DEPTH				FROM	TO	OR		N-Value	Qu	LL	PI	%M		
FT.	IN.	IN.	ELEV.	FT.	FT.	RUN NO.								
													Lean CLAY (CL) - with shale fragments and shale like structure - orangish brown and gray - dry - very stiff to very hard (RESIDUUM)	
2.5			1103.5	1.0	2.5	1	SS	25						
														Weathered Shale - gray - dry
5.0			1101.0	3.5	4.7	2	SS	50/2"						
7.5			1098.5											
														Auger Refusal at 6.0 Feet
10.0			1096.0											
12.5			1093.5											
15.0			1091.0											
17.5			1088.5											
20.0			1086.0											

REMARKS:



Bean Station
Knoxville, Tennessee
GEOServices Project # 21-16438

LOG OF BORING **B-3**

SHEET 1 OF 1

DRILLER Fred Reynolds

ON-SITE REP.

DRY ON COMPLETION ? Yes

BORING NO. / LOCATION

B-3

DATE July 8, 2016

SURFACE ELEV. 1107.0 FT.

REFUSAL: Yes DEPTH 7.7 FT.

ELEV. 1099.3 FT.

SAMPLED 7.7 FT. 2.3 M

TOP OF ROCK DEPTH FT.

ELEV. FT.

BEGAN CORING DEPTH FT.

ELEV. FT.

FOOTAGE CORED (LF) FT.

BOTTOM OF HOLE DEPTH FT.

ELEV. 1107.0 FT.

WATER LEVEL DATA (IF APPLICABLE)

COMPLETION: DEPTH Dry FT.

ELEV. FT.

AFTER 1 HRS: DEPTH Dry FT.

ELEV. FT.

AFTER 24 HRS: DEPTH TNP FT.

ELEV. FT.

BORING ADVANCED BY:

POWER AUGERING X

PROPOSED FFE: FT.

STRATUM DEPTH		SAMPLE DEPTH		SAMPLE OR RUN NO.	SAMPLE TYPE	FIELD RESULTS		LABORATORY RESULTS			STRATUM DESCRIPTION
FT.	ELEV.	FROM FT.	TO FT.			N-Value	Qu	LL	PI	%M	
0.0	1107.0										Topsoil (6 inches)
2.5	1104.5	1.0	2.5	1	SS	21					Lean CLAY (CL) - with shale fragments - orangish brown and gray - moist - very stiff (RESIDUUM)
5.0	1102.0	3.5	5.0	2	SS	38					
7.5	1099.5	6.0	7.5	3	SS	33					
10.0	1097.0										Auger Refusal at 7.7 feet
12.5	1094.5										
15.0	1092.0										
17.5	1089.5										
20.0	1087.0										

REMARKS:



Bean Station
Knoxville, Tennessee
GEOServices Project # 21-16438

LOG OF BORING **B-4**

SHEET 1 OF 1

DRILLER Fred Reynolds

ON-SITE REP. _____

BORING NO. / LOCATION

B-4

DRY ON COMPLETION ?

Yes

DATE July 8, 2016

SURFACE ELEV. 1106.0 FT.

REFUSAL: Yes DEPTH 20.0 FT.

ELEV. 1086.0 FT.

SAMPLED 20.0 FT. 6.1 M

TOP OF ROCK DEPTH _____ FT.

ELEV. _____ FT.

BEGAN CORING DEPTH _____ FT.

ELEV. _____ FT.

FOOTAGE CORED (LF) _____ FT.

BOTTOM OF HOLE DEPTH 20.0 FT.

ELEV. 1086.0 FT.

WATER LEVEL DATA (IF APPLICABLE)

COMPLETION: DEPTH Dry FT.

ELEV. _____ FT.

AFTER 1 HRS: DEPTH Dry FT.

ELEV. _____ FT.

AFTER 24 HRS. DEPTH TNP FT.

ELEV. _____ FT.

BORING ADVANCED BY:

POWER AUGERING X

PROPOSED FFE: _____ FT.

STRATUM DEPTH FT. / ELEV.	SAMPLE DEPTH		SAMPLE OR RUN NO.	SAMPLE TYPE	FIELD RESULTS		LABORATORY RESULTS			STRATUM DESCRIPTION
	FROM FT.	TO FT.			N-Value	Qu	LL	PI	%M	
2.5 - 1103.5	1.0	2.5	1	SS	7					Lean CLAY (CL) - with silt - brown - wet - firm (RESIDUUM)
5.0 - 1101.0	3.5	5.0	2	SS	20					Lean CLAY (CL) - with shale fragments and shale like structure - orangish brown and gray - dry - very stiff (RESIDUUM)
7.5 - 1098.5	6.0	7.5	3	SS	20					
10.0 - 1096.0	8.5	10.0	3	SS	34					
12.5 - 1093.5										Weathered Shale - gray - very hard
15.0 - 1091.0	13.5	14.7	4	SS	50/2'					
17.5 - 1088.5										
20.0 - 1086.0	18.5	18.8	5	SS	50/4'					Auger Refusal at 20.0 Feet

REMARKS: _____



Bean Station
Knoxville, Tennessee
GEOServices Project # 21-16438

LOG OF BORING B-5

SHEET 1 OF 1

DRILLER Fred Reynolds

ON-SITE REP. _____

BORING NO. / LOCATION

B-5

DRY ON COMPLETION ?

NO

DATE July 8, 2016

SURFACE ELEV. 1108.0 FT.

REFUSAL: Yes DEPTH 9.0 FT.

ELEV. 1099.0 FT.

SAMPLED 9.0 FT. 2.7 M

TOP OF ROCK DEPTH 9.0 FT.

ELEV. 1099.0 FT.

BEGAN CORING DEPTH 9.0 FT.

ELEV. 1099.0 FT.

FOOTAGE CORED (LF) 10.0 FT.

BOTTOM OF HOLE DEPTH 19.0 FT.

ELEV. 1089.0 FT.

BORING ADVANCED BY:

POWER AUGERING

X

PROPOSED FFE: _____ FT.

WATER LEVEL DATA (IF APPLICABLE)

COMPLETION: DEPTH Dry FT.

ELEV. _____ FT.

AFTER 1 HRS: DEPTH Dry FT.

ELEV. _____ FT.

AFTER 24 HRS: DEPTH TNP FT.

ELEV. _____ FT.

STRATUM				SAMPLE DEPTH		SAMPLE		FIELD		LABORATORY			STRATUM DESCRIPTION
DEPTH				FROM	TO	OR	SAMPLE TYPE	RESULTS	Qu	RESULTS			
FT.			ELEV.	FT.	FT.	RUN NO.				LL	PI	%M	
—	—	—	—	1.0	1.8	1	SS	50/4"					Topsoil (4 inches)
2.5	—	—	1105.5										Lean CLAY (CL) - with silt and shale fragments - orangish brown and gray - dry - very hard (RESIDUUM)
—	—	—	—										
—	—	—	—	3.5	4.3	2	SS	50/3"					
5.0	—	—	1103.0										
—	—	—	—										
—	—	—	—	6.0	6.5	3	SS	50/0					Weathered Shale - orangish brown and gray - very hard
7.5	—	—	1100.5										
—	—	—	—										
—	—	—	—	8.5	8.5	3	SS	50/0					
10.0	—	—	1098.0										
—	—	—	—										
12.5	—	—	1095.5										Auger Refusal at 9.0 Feet Begin Coring at 9.0 feet Run #1 (9.0 to 14.0 feet) REC - 40% RQD - 0%
—	—	—	—										Weathered Shale - orangish brown and brown - with calcite healed veins and evidence of water transport - moderately fractured and moderately to heavily weathered
15.0	—	—	1093.0										Run #2 (14.0 to 19.0 feet) REC - 40% RQD - 0%
—	—	—	—										
17.5	—	—	1090.5										Weathered Shale - orangish brown and brown - moderately fractured and moderately to heavily weathered
—	—	—	—										
20.0	—	—	1088.0										Coring Terminated at 19.0 Feet

REMARKS: _____



Bean Station
Knoxville, Tennessee
GEOServices Project # 21-16438

LOG OF BORING **B-6**

SHEET 1 OF 1

DRILLER Fred Reynolds

ON-SITE REP. _____

BORING NO. / LOCATION

B-6

DRY ON COMPLETION ?

Yes

DATE July 8, 2016

SURFACE ELEV. _____ FT.

REFUSAL: Yes DEPTH 22.5 FT.

ELEV. 1106.0 FT.

SAMPLED 22.5 FT. 6.9 M

TOP OF ROCK DEPTH _____ FT.

ELEV. _____ FT.

BEGAN CORING DEPTH _____ FT.

ELEV. _____ FT.

FOOTAGE CORED (LF) _____ FT.

BOTTOM OF HOLE DEPTH 22.5 FT.

ELEV. -22.5 FT.

WATER LEVEL DATA (IF APPLICABLE)

COMPLETION: DEPTH Dry FT.

ELEV. _____ FT.

AFTER 1 HRS: DEPTH Dry FT.

ELEV. _____ FT.

AFTER 24 HRS: DEPTH TNP FT.

ELEV. _____ FT.

BORING ADVANCED BY:

POWER AUGERING

X

PROPOSED FFE: _____ FT.

STRATUM DEPTH	SAMPLE DEPTH		SAMPLE OR RUN NO.	SAMPLE TYPE	FIELD RESULTS		LABORATORY RESULTS			STRATUM DESCRIPTION
	FROM	TO			N-Value	Qu	LL	PI	%M	
FT. ELEV.	FT.	FT.								
-										Topsoil (7 inches)
2.5 - -2.5	1.0	2.5	1	SS	10					
5.0 - -5.0	3.5	5.0	2	SS	12					
7.5 - -7.5	6.0	7.5	3	SS	21					Lean CLAY (CL) - with silt - light brown and orangish brown - moist - stiff (RESIDUUM)
10.0 - -10.0	8.5	10.0	4	SS	18					
12.5 - -12.5										
15.0 - -15.0	13.5	15.0	5	SS	19					
17.5 - -17.5										Weathered Shale - gray - dry - very stiff to very hard
20.0 - -20.0	18.5	19.1	6	SS	50/1"					

Auger Refusal at 22.5 Feet

REMARKS: _____



Bean Station
Knoxville, Tennessee
GEOServices Project # 21-16438

LOG OF BORING **B-7**

SHEET 1 OF 1

DRILLER Fred Reynolds

ON-SITE REP. _____

BORING NO. / LOCATION

B-7

DRY ON COMPLETION ?

No

DATE July 8, 2016

SURFACE ELEV. 1106.0 FT.

REFUSAL: Yes DEPTH 17.2 FT.

ELEV. 1088.8 FT.

SAMPLED 17.2 FT. 5.2 M

TOP OF ROCK DEPTH _____ FT.

ELEV. _____ FT.

BEGAN CORING DEPTH _____ FT.

ELEV. _____ FT.

FOOTAGE CORED (LF) _____ FT.

BOTTOM OF HOLE DEPTH 17.2 FT.

ELEV. 1088.8 FT.

BORING ADVANCED BY:

POWER AUGERING

X

PROPOSED FFE: _____ FT.

WATER LEVEL DATA (IF APPLICABLE)

COMPLETION: DEPTH 8.0 FT.

ELEV. _____ FT.

AFTER 1 HRS: DEPTH Dry FT.

ELEV. _____ FT.

AFTER 24 HRS: DEPTH TNP FT.

ELEV. _____ FT.

STRATUM DEPTH		SAMPLE DEPTH		SAMPLE OR RUN NO.	SAMPLE TYPE	FIELD RESULTS		LABORATORY RESULTS			STRATUM DESCRIPTION
FT.	ELEV.	FROM FT.	TO FT.			N-Value	Qu	LL	PI	%M	
2.5	1103.5	1.0	2.5	1	SS	8					Lean CLAY (CL) - with abundant wood fragments at depth - brown and dark brown - moist (FILL)
5.0	1101.0	3.5	5.0	2	SS	3					
7.5	1098.5	6.0	6.8	3	SS	50/3"					Lean CLAY (CL) - with shale fragments and shale like structure - gray - moist to wet (RESIDUUM)
10.0	1096.0	8.5	8.9	4	SS	50/5"					
12.5	1093.5										Weathered Shale - gray - dry - very hard
15.0	1091.0	13.5	13.7	5	SS	50/2"					
17.5	1088.5										Auger Refusal at 17.2 Feet
20.0	1086.0										

REMARKS: _____



Bean Station
Knoxville, Tennessee
GEOServices Project # 21-16438

LOG OF BORING **B-8**

SHEET 1 OF 1

DRILLER: Fred Reynolds
ON-SITE REP.:

BORING NO. / LOCATION

B-8

DRY ON COMPLETION ?

Yes

DATE July 8, 2016

SURFACE ELEV. 1113.0 FT.

REFUSAL: Yes DEPTH 16.7 FT.

ELEV. 1096.3 FT.

SAMPLED 16.7 FT. 5.1 M

TOP OF ROCK DEPTH FT.

ELEV. FT.

BEGAN CORING DEPTH FT.

ELEV. FT.

FOOTAGE CORED (LF) FT.

BOTTOM OF HOLE DEPTH 16.7 FT.

ELEV. 1096.3 FT.

BORING ADVANCED BY:

POWER AUGERING

X

WATER LEVEL DATA (IF APPLICABLE)

COMPLETION: DEPTH Dry FT.

ELEV. FT.

AFTER 1 HRS: DEPTH Dry FT.

ELEV. FT.

AFTER 24 HRS: DEPTH TNP FT.

ELEV. FT.

PROPOSED FFE: FT.

STRATUM DEPTH				SAMPLE DEPTH		SAMPLE OR RUN NO.	SAMPLE TYPE	FIELD RESULTS		LABORATORY RESULTS			STRATUM DESCRIPTION
FT.	IN.	FEET	ELEV.	FROM FT.	TO FT.			N-Value	Qu	LL	PI	%M	
2.5	1110.5			1.0	1.6	1	SS	50/1"					Weathered Shale - gray - dry - very hard
5.0	1108.0			3.5	3.9	2	SS	50/4"					
7.5	1105.5			6.0	6.4	3		50/5"					
10.0	1103.0			8.5	9.2	4	SS	50/2"					
15.0	1098.0			13.5	13.5	5	SS	50/0					
17.5	1095.5												Auger Refusal at 16.7 Feet
20.0	1093.0												

REMARKS: _____



Appalachian Electric Cooperative Substation

GEOservices Project No. 21-19057

February 13, 2019

SOIL DATA SUMMARY

Boring Number	Sample Number	Depth (feet)	Natural Moisture Content	Atterberg Limits			Soil Type	Percent Organic Content
				LL	PL	PI		
B-3	1	1.0-2.5'	23.9%					
	2	3.5-5.0'	26.7%					
	3	6.0-7.5'	23.3%					
	4	8.5-10.0'	24.3%					
	5	13.5-15.0'	31.4%					
	6	18.5-20.0'	32.3%					
	7	23.5-25.0'	41.1%					
	8	28.5-30.0'	41.0%					
	9	33.5-35.0'	29.8%					
	10	38.5-40.0'	29.9%					
	11	43.5-45.0'	35.9%					
	12	48.5-50.0'	27.8%					
B-4	1	1.0-2.5'	24.0%					
	2	3.5-5.0'	23.6%	71	18	53	CH	
	3	6.0-7.5'	22.7%					
	4	8.5-10.0'	34.3%					
	5	13.5-15.0'	41.0%					
	6	18.5-20.0'	39.6%					
	7	23.5-25.0'	50.3%					
	8	28.5-30.0'	48.4%					
	9	33.5-35.0'	44.0%					
	10	38.5-40.0'	41.8%					
	11	43.5-45.0'	59.3%					
	12	48.5-50.0'	63.2%					
	13	53.5-55.0'	63.3%					
	15	63.5-65.0'	51.7%					



Appalachian Electric Cooperative Substation

GEOservices Project No. 21-19057

February 13, 2019

SOIL DATA SUMMARY

Boring Number	Sample Number	Depth (feet)	Natural Moisture Content	Atterberg Limits			Soil Type	Percent Organic Content
				LL	PL	PI		
B-8	1	1.0-2.5'	25.7%					8.1
	3	6.0-7.5'	27.7%					
	4	8.5-10.0'	34.9%					
	5	13.5-15.0'	38.0%					
	6	18.5-20.0'	41.5%					
	7	23.5-25.0'	38.8%					
B-9	1	1.0-2.5'	26.8%					4.9
	2	3.5-5.0'	27.0%	58	20	38	CH	
	3	6.0-7.5'	28.8%					
	4	8.5-10.0'	29.9%					
	5	13.5-15.0'	38.6%					
	6	18.5-20.0'	41.3%					
	7	23.5-25.0'	55.9%					
	8	28.5-30.0'	63.8%					
	9	33.5-35.0'	59.2%					
B10	1	1.0-2.5'	27.1%					
	2	3.5-5.0'	27.5%					
	3	6.0-7.5'	28.7%	82	25	57	CH	
	4	8.5-10.0'	33.6%					
	5	13.5-15.0'	36.2%					
	6	18.5-20.0'	37.1%					
	7	23.5-25.0'	37.3%					



Mascot Dolomite

[Detailed description](#)

Light-gray, fine-grained, well-bedded cherty dolomite; mottled (red and green) dolomite characteristic; interbeds of bluish-gray limestone in upper part; chert-matrix quartz sandstone at base. Erosional unconformity at top. Thickness 350 to 800 feet.

Appendix C: Environmental Calculations

Transformer oil runoff

one(1) transformer @ 750 gallons: 750 gallons

three(3) voltage regulators @ 55 gallons: 165 gallons

$$750\text{ g} + 165\text{ g} = 915\text{ gallons}$$

$$1\text{ gallon} = 0.00378541\text{ gallons}$$

$$915\text{ g} (0.00378541) = 3.5\text{ m}^3$$

$$\text{factor of safety} = 2$$

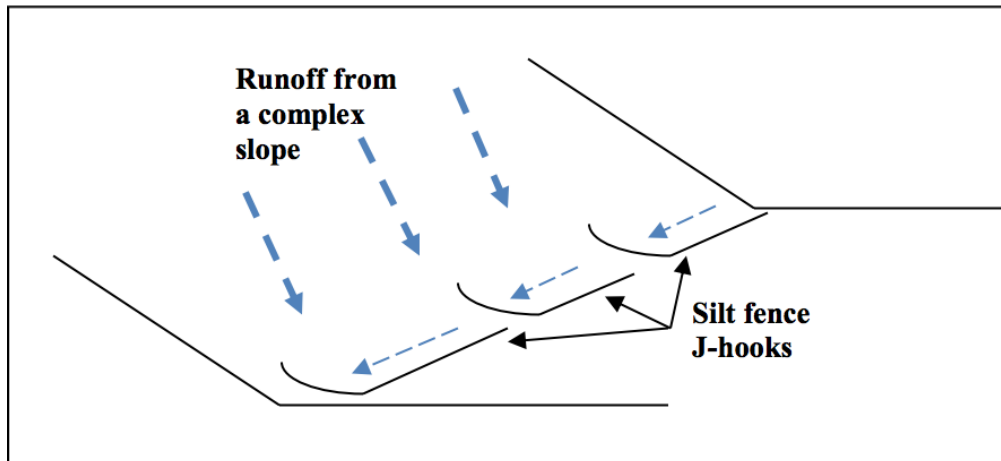
$$\text{final oil containment pond volume} = \underline{7\text{ m}^3}$$

$$1\text{ gallon} = 0.133681\text{ ft}^3$$

$$915\text{ g} (0.133681\text{ ft}^3) = 122.4\text{ ft}^3$$

$$\text{factor of safety} = 2$$

$$\text{final oil containment pond volume} = \underline{244.8\text{ ft}^3}$$



Silt Fence J-Hook Layout

	Volume (Gallons)	Quantity	Total Oil (Gallons)
Transformer Oil	750	1	750
Voltage Regulator Oil	55	3	165
			915

Maximum Oil Runoff

Appendix D: Water Resources Calculations

25 year, 24 hour storm

$$Q_{\text{before}} = (1.10)(0.41)(5.5 \text{ in/hr})(3.25 \text{ ac}) = 8.01 \text{ cfs}$$

$$Q_{\text{after}} = (1.10)(0.70)(5.5 \text{ in/hr})(3.25 \text{ ac}) = 13.76 \text{ cfs}$$

all values from runoff coefficient table in Appendix D

Grading

$$\% \text{ slope} = \Delta y / \Delta x$$

$$2\% = \Delta y / 100 \text{ ft}$$

$\Delta y = 2 \text{ ft}$ of elevation decrease
from West to East beginning
at the 1250' elevation point.

pre-existing slope for erosion control plan

$$\% \text{ slope} = \Delta y / \Delta x$$

$$\% = (1252 - 1240) / 224 \text{ ft} = 0.0536 = 5.36\%$$

$$5.36\% < 33.3\%$$

silt fence is sufficient

25-year 24-hour maximum rainwater runoff calculations:

Maximum Runoff Equation: $Q = (\text{frequency factor}) * C * I * A$

C= Runoff Coefficient

I=Average Rainfall Intensity (in/hr)

A= Area (acres)

Land Use	Runoff Coefficient (C) by Hydrologic Soil Group and Ground Slope											
	A			B			C			D		
	<2%	2 - 6%	>6%	<2%	2 - 6%	>6%	<2%	2 - 6%	>6%	<2%	2 - 6%	>6%
Forest	0.08	0.11	0.14	0.10	0.14	0.18	0.12	0.16	0.20	0.15	0.20	0.25
Meadow	0.14	0.22	0.30	0.20	0.28	0.37	0.26	0.35	0.44	0.30	0.40	0.50
Pasture	0.15	0.25	0.37	0.23	0.34	0.45	0.30	0.42	0.52	0.37	0.50	0.62
Farmland	0.14	0.18	0.22	0.16	0.21	0.28	0.20	0.25	0.34	0.24	0.29	0.41
Res. 1 acre	0.22	0.26	0.29	0.24	0.28	0.34	0.28	0.32	0.40	0.31	0.35	0.46
Res. 1/2 acre	0.25	0.29	0.32	0.28	0.32	0.36	0.31	0.35	0.42	0.34	0.38	0.46
Res. 1/3 acre	0.28	0.32	0.35	0.30	0.35	0.39	0.33	0.38	0.45	0.36	0.40	0.50
Res. 1/4 acre	0.30	0.34	0.37	0.33	0.37	0.42	0.36	0.40	0.47	0.38	0.42	0.52
Res. 1/8 acre	0.33	0.37	0.40	0.35	0.39	0.44	0.38	0.42	0.49	0.41	0.45	0.54
Industrial	0.85	0.85	0.86	0.85	0.86	0.86	0.86	0.86	0.87	0.86	0.86	0.88
Commercial	0.88	0.88	0.89	0.89	0.89	0.89	0.89	0.89	0.90	0.89	0.89	0.90
Streets: ROW	0.76	0.77	0.79	0.80	0.82	0.84	0.84	0.85	0.89	0.89	0.91	0.95
Parking	0.95	0.96	0.97	0.95	0.96	0.97	0.95	0.96	0.97	0.95	0.96	0.97
Disturbed Area	0.65	0.67	0.69	0.66	0.68	0.70	0.68	0.70	0.72	0.69	0.72	0.75

Runoff Coefficient Table

$$Q (\text{after}) = (1.10) * (0.70) * (5.5 \text{ in/hr}) * (3.25 \text{ acres}) = 13.76 \text{ cfs}$$

$$Q (\text{before}) = (1.10) * (0.41) * (5.5 \text{ in/hr}) * (3.25 \text{ acres}) = 8.01 \text{ cfs}$$

Appendix E: Transportation Study

Time Slot	Nourthbound	Traffic	Southbound	Traffic
	Count	Time (sec)	Count	Time (sec)
7:30 - 7:45	15	3.4	15	3.4
		3.86		4.38
		3.49		3.23
		3.03		2.85
		3.63		5.12
		4.08		3
		3.56		3.85
		3.62		3.3
7:45 - 8:00	12	3.55	10	3.32
		3.73		3.98
		3.63		2.82
		3.63		3.02
		3.86		3.3
		2.76		3.42
		3.58		3.62
		2.65		
		3.22		
8:00 - 8:15	15	3.71	14	4.63
		4.26		3.72
		4.09		3.49
		3.96		3.83
		3.46		3.19
		3.58		3.63
		3.7		2.95
		2.33		3.4
		4.38		3.56
8:15 - 8:30	13	3.38	9	3.72
		2.85		
		3.62		
		3.55		
		4.22		3.36
		3.2		3.39
		2.68		3.96
		3.53		3.78
		3.4		2.96
8:30 - 8:45	21	3.13	18	3.96
		4.25		3
		3.02		3.92
		2.85		
		3.23		
		3.25		3.16
		3.32		2.85
		3.66		3.68
		2.15		3.9
8:45 - 9:00	17	2.87	25	4.82
		3.22		3.55
		3.13		4
		3.48		3.82
		3.03		4.78
		3.83		3.53
		3.18		3.73
		3.52		3.53
		4.19*		3.95
				3.73
				3.65
				4.15
		2.86		3.55
		3.35		3.33
		2.96		4.58
		3.45		3.32
		3.5		4.43
		3.46		3.36
		3.08		3.15
		3.46		4.36
		2.95		4.05
		2.88		2.95
		3.53		4.41
		3.12		3.3
				4.06
				3.13
				3.11
				4.23
				4.03

Average

Northbound	Southbound
3.3890625	3.655151515
59.01337022	54.71729398
40.23638878	37.3072459

	Northbound	Southbound
Total Traffic Count	93	91
Average Time	3.39	3.66
Average Speed (ft/s)	59.01	54.72
Average Speed (mph)	40.24	37.31

3.236666667 61.79196704 42.13088662

85.83690987 58.52516582

93.02325581 63.42494715
66.66666667 45.45454545

*=heavy

	Northbound	Southbound
Total Traffic Count	93	91
Average Time	3.39	3.66
Average Speed (ft/s)	59.01	54.72
Average Speed (mph)	40.24	37.31

	Nourthbound		Southbound	
	Count	Traffic Time (sec)	Count	Traffic Time (sec)
7:30 - 7:45	15	3.4 3.86 3.49 3.03 3.63 4.08 3.56 3.62	15	3.4 4.38 3.23 2.85 5.12 3 3.85 3.3
7:45 - 8:00	12	3.55 3.73 3.63 3.63 3.86 2.76 3.58 2.65 3.22	10	3.32 3.98 2.82 3.02 3.3 3.42 3.62
8:00 - 8:15	15	3.71 4.26 4.09 3.96 3.46 3.58 3.7 2.33 4.38 3.38 2.85 3.62 3.55	14	4.63 3.72 3.49 3.83 3.19 3.63 2.95 3.4 3.56 3.72
8:15 - 8:30	13	4.22 3.2 2.68 3.53 3.4 3.13 4.25 3.02 2.85 3.23	9	3.36 3.39 3.96 3.78 2.96 3.96 3 3.92
8:30 - 8:45	21	3.25 3.32 3.66 2.15 2.87 3.22 3.13 3.48 3.03 3.83 3.18 3.52 4.19*	18	3.16 2.85 3.68 3.9 4.82 3.55 4 3.82 4.78 3.53 3.73 3.53 3.95 3.73 3.65 4.15
8:45 - 9:00	17	2.86 3.35 2.96 3.45 3.5 3.46 3.08 3.46 2.95 2.88 3.53 3.12	25	3.55 3.33 4.58 3.32 4.43 3.36 3.15 4.36 4.05 2.95 4.41 3.3 4.06 3.13 3.11 4.23 4.03

11' lane width

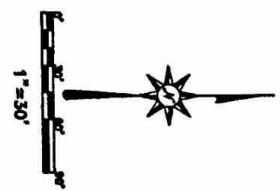
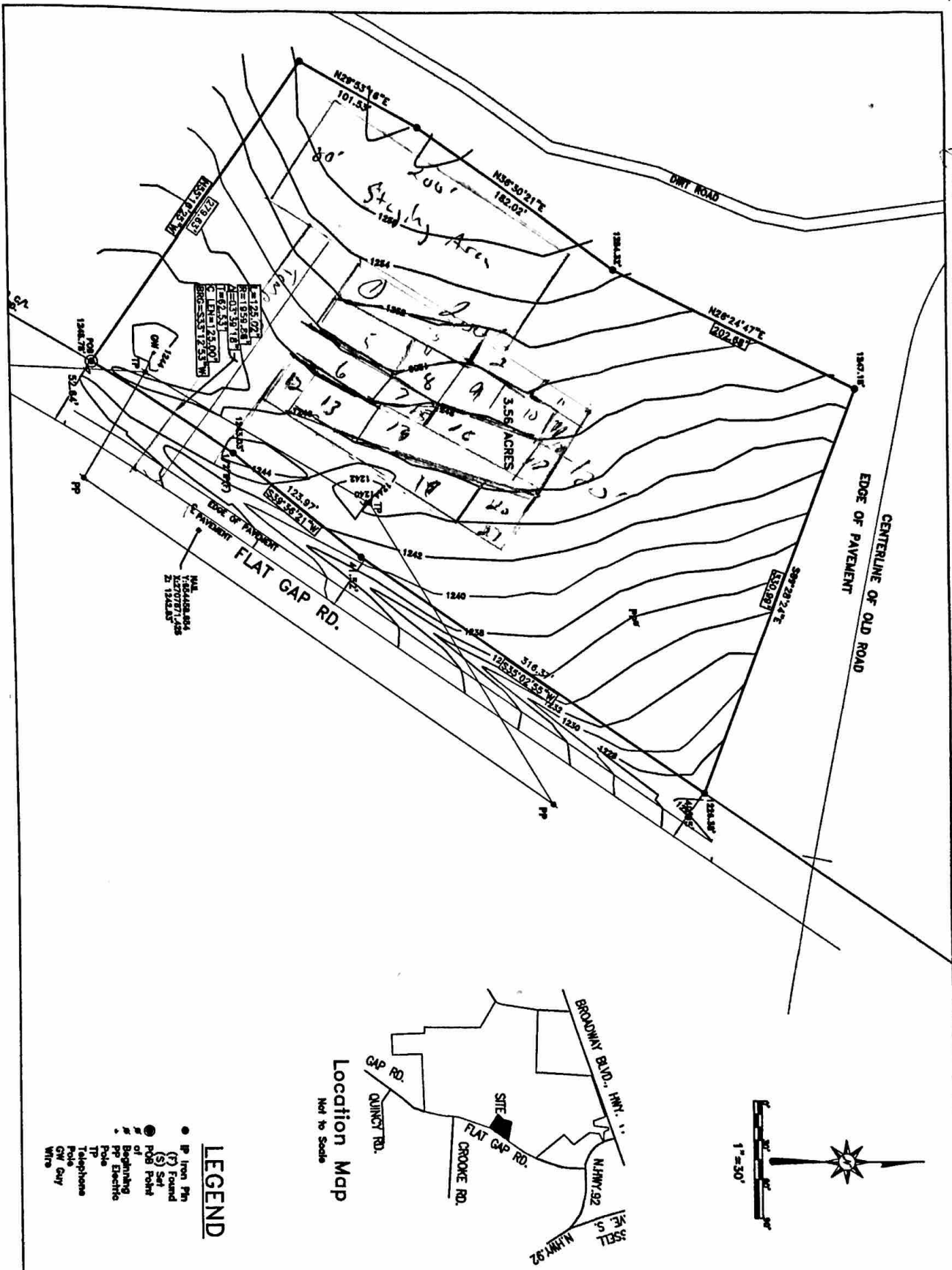
Left Turn 200' - 400'
away from study
Southbound

14' Bridge
200' Thruway

	Northbound	Heavy	Southbound	Heavy
7:30-7:45	LHT 1111 1111	1	1111 2111 1111	
7:45-8:00	LHT 1111 11		LHT 1111	
8:00-8:15	1111 1111 1111		1111 1111 1111	
8:15-8:30	1111 1111 1111		2111 1111	
8:30-8:45	1111 1111 1111 1111	1	1111 1111 1111 1111	
8:45-9:00	1111 1111 1111 11		1111 1111 1111 1111 1111	

Appendix F: Construction Scheduling

Earthwork



Location Map
Not to Scale

- LEGEND**
- Iron Pin
 - (T) Found
 - (S) Set
 - P.O.B. Point
 - of beginning
 - of ending
 - of center
 - of edge
 - of line
 - of wire
 - of pole
 - of guy

C1.1 Existing Layout	1 1.30.19 1.30.19 1.30.19	OSHKOSH SUBSTATION C2RL INC ENGINEERS DATE	1. November 1. Revision 12/2/20 2. November 2. Revision 1/28/19		SMOKY MOUNTAIN FOUNDATION, INC STUDENT WORK NOT FOR CONSTRUCTION 851 Heyland Drive, Knoxville, Tennessee, 37906 ph: 615 408 5062
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Zinc Substation

Earthwork

$$\text{Section 1} = \left(\left(\frac{1250 + 1259}{2} \right) - (1248) \right) (0.5) (20') (90') = 6750 \text{ ft}^3 \text{ cut}$$

$$2 = \left(\left(\frac{1250 + 1252}{2} \right) - (1248) \right) (20') (80') = 3000 \text{ ft}^3 \text{ cut}$$

$$3 = (1251 - 1248) (0.5) (60) (20') = 300 \text{ ft}^3 \text{ cut}$$

$$4 = (1251 - 1248) (0.5) (40) (40') = 2400 \text{ ft}^3 \text{ cut}$$

$$5 = (1251 - 1248) (70') (25') = 5250 \text{ ft}^3 \text{ cut}$$

$$6 = \left(\left(\frac{1250 + 1244}{2} \right) - (1248) \right) (70') (25') = 1750 \text{ ft}^3 \text{ cut}$$

$$7 = \left(\left(\frac{1250 + 1244}{2} \right) - (1248) \right) (35') (25') (0.5) = 437.5 \text{ ft}^3 \text{ cut}$$

$$8 = \left(\left(\frac{1250 + 1248}{2} \right) - (1248) \right) (40') (35') (0.5) = 700 \text{ ft}^3 \text{ cut}$$

$$9 = \left(\left(\frac{1250 + 1244}{2} \right) - (1248) \right) (40') (30') = 1200 \text{ ft}^3 \text{ cut}$$

$$10 = \left(\left(\frac{1250 + 1248}{2} \right) - (1248) \right) (40') (30') = 1200 \text{ ft}^3 \text{ cut}$$

$$11 = \left(\left(\frac{1250 + 1244}{2} \right) - (1248) \right) (25') (25') (0.5) = 312.5 \text{ ft}^3 \text{ cut}$$

$$\sum \text{cut} = 26000 \text{ ft}^3 \text{ cut}$$

$$12 = \left(1248 - \left(\frac{1248 + 1246}{2} \right) \right) (20') (40') = 800 \text{ ft}^3 \text{ fill}$$

$$13 = \left(1248 - \left(\frac{1248 + 1246}{2} \right) \right) (50') (35') = 1750 \text{ ft}^3 \text{ fill}$$

$$14 = \left(1248 - \left(\frac{1248 + 1246}{2} \right) \right) (0.5) (140') (35') = 3675 \text{ ft}^3 \text{ fill}$$

$$15 = \left(1248 - \left(\frac{1248 + 1246}{2} \right) \right) (0.5) (40') (15') = 300 \text{ ft}^3 \text{ fill}$$

$$16 = \left(1248 - \left(\frac{1248 + 1242}{2} \right) \right) (80') (30') = 1200 \text{ ft}^3 \text{ fill}$$

$$17 = \left(1248 - \left(\frac{1248 + 1246}{2} \right) \right) (20') (30') = 6000 \text{ ft}^3 \text{ fill}$$

$$18 = \left(1248 - \left(\frac{1248 + 1242}{2} \right) \right) (0.5) (20') (20') = 100 \text{ ft}^3 \text{ fill}$$

$$19 = \left(1248 - \left(\frac{1246 + 1245}{2} \right) \right) (0.5) (150') (40') = 7500 \text{ ft}^3 \text{ fill}$$

$$20 = \left(1248 - \left(\frac{1246 + 1244}{2} \right) \right) (30') (40') = 3600 \text{ ft}^3 \text{ fill}$$

$$21 = \left(1248 - \left(\frac{1246 + 1243}{2} \right) \right) (0.5) (40') (20') = 1800 \text{ ft}^3 \text{ fill}$$

$$\sum \text{fill} = 26725 \text{ ft}^3$$

$$\sum \text{cut} - \text{fill} = 26000 \text{ ft}^3 - 26725 \text{ ft}^3 = 725 \text{ ft}^3 \text{ fill}$$

$$725 \text{ ft}^3 \left(\frac{1 \text{ yd}^3}{27 \text{ ft}^3} \right) = 26 \text{ yd}^3 \text{ fill}$$

Fence + Barbwire

$$\text{Northside} = \sqrt{(3311)^2 + (1247.14 - 1226.38)^2} = 331.65 = 332$$

$$\text{Southside} = \sqrt{(279.63)^2 + (1256 - 1246)^2} = 279.8 = 280$$

$$\text{East side} = 125.02 + 123.97 + 316.77 - (12 \text{ gates}) = 553.6 = 554$$

$$\text{West side} = 101.57 + 182.02 + 202.68 = 485.2 = 486$$

$$\text{Total Fence} = 332 + 280 + 554 + 486 = 1652'$$

$$\text{Total Barbwire} = \text{Total Fence} + 12' = 1652 + 12' = 1664'$$

$$\text{Gates} = 2$$

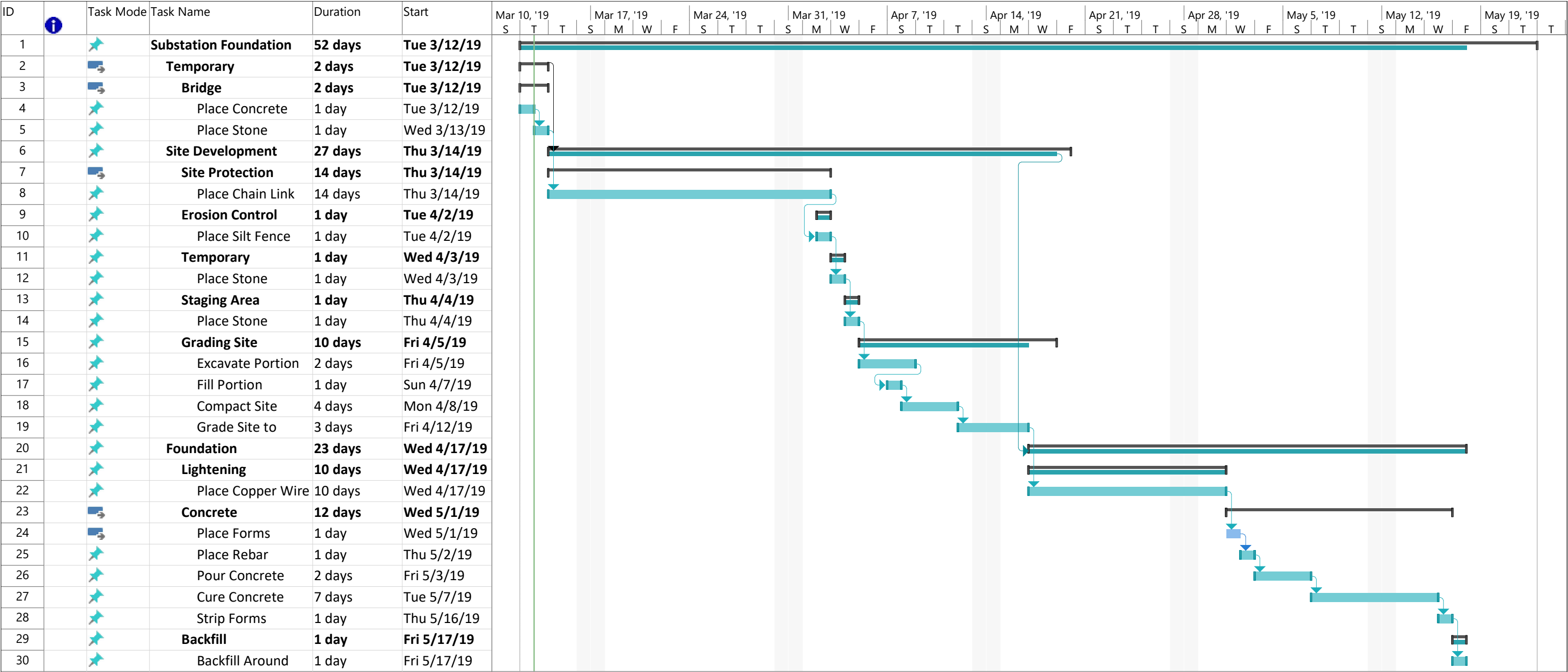
$$\text{Corner / End Posts} = 4 + 2 = 6$$

TDOT D Stone

$$\text{Stepping Area} = 200' \times 80' \times (4'') \left(\frac{1}{12} \right) = 533.33 \text{ ft}^3$$

$$\text{Road} = 220' \times 20' \times (4'') \left(\frac{1}{12} \right) = 146.67 \text{ ft}^3 \approx 147 \text{ ft}^3$$

$$\begin{aligned} \text{Bridge} &= (12' \times 15' \times \frac{1}{24}) (10') + (4' \times 10' \times \frac{1}{24}) (10') = 60.0 \text{ ft}^3 \\ &= (12' \times 10') + 4' \times (12' \times 10') = 600 \text{ ft}^2 \end{aligned}$$



Project: Senior Design Construc
Date: Wed 3/13/19

Task

Split

Milestone

Summary

Project Summary

Inactive Task

Inactive Milestone

Inactive Summary

Manual Task

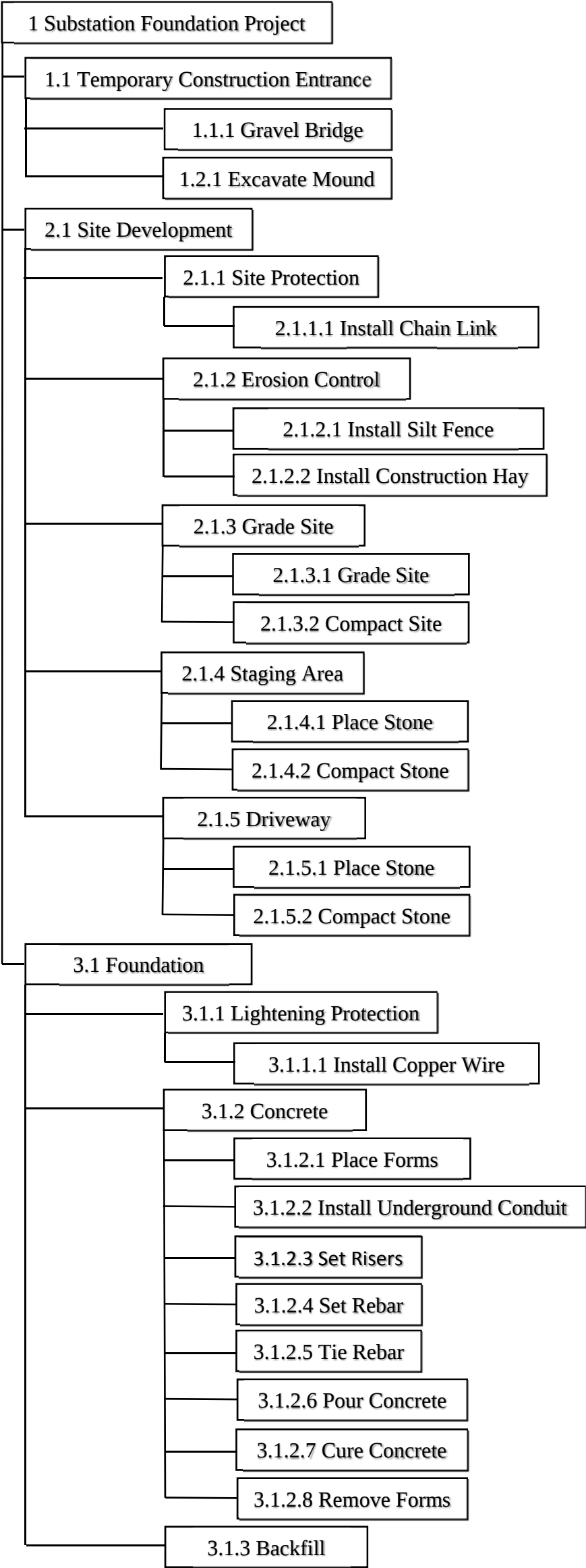
Duration-only

Manual Summary Rollup

Manual Summary

Start-onlyFinish-onlyExternal TasksExternal MilestoneDeadlineProgressManual Progress

Page 1



Appendix G: Item Cost Breakdown

Cost Analysis												
Activity	Quantity	Unit	Daily Output	Duration (Days)	Material \$/Unit	Material Cost	Labor \$/Unit	Labor Cost	Equipment \$/Unit	Equipment Cost	Total Cost	Reference
Place Concrete Pipe	12	L.F.	-	0.5	55.98	671.76	-	-	-	-	671.76	TDOT 607-03.02
Stone for Construction Entrance	5 layers of 120	S.F.	6000	0.1	38	22800	0.22	132	0.02	12	22944	RS Means - 31.23.23.17-0800
Silt Fence	544	L.F.	950	0.5726315789	1.35	734.4	0.59	320.96	0	0	1055.36	TDOT 209.08.03
Stone for Road	55	C.Y.	600	0.09166666667	38	2090	30	1650	3.44	189.2	3929.2	RS Means - 31.05.16.10-0300
Stone for Staging Area	311	C.Y.	600	0.33	38	11818	30	9330	3.44	1069.84	22217.84	RS Means - 31.05.16.10-0300
Chain Link Fence	1652	L.F.	-	4	12.58	20782.16	10	1600	-	-	22382.16	TDOT 707-08.30
End and Corner Post	6	Ea.	-	2	241.34	1448.04	10	800	-	-	2248.04	TDOT 707-01.11
6' Gate	2	Ea.	-	1	1055	2110	10	400	-	-	2510	TDOT 707-01.13
Barbwire	1664	L.F.	-	3	0.48	798.72	10	1200	-	-	1998.72	TDOT 707-14.03
Excavation	963	B.C.Y	800	1.20375	-	-	0.62	597.06	0.91	876.33	1473.39	RS Means - 31.26.16.42-0200
Fill	990	L.C.Y	1000	0.99	-	-	0.28	277.2	1.05	1039.5	1316.7	RS Means - 31.23.23.17-0020
Compaction	24000	S.F.	7500	3.2	-	-	0.22	5280	0.33	7920	13200	RS Means - 31.25.17.16-00200
Grading	24000	S.F.	8900	2.696629213	-	-	0.06	1440	0.6	14400	15840	RS Means - 31.22.16.10-3300
Lightenign Protection Copper Wire	4000	L.F.	-	10	2.06	8240	20	3200	-	-	11440	TDOT 730-08.30
Place Forms	180	L.F.	1200	0.15	1.64	295.2	0.79	142.2	-	-	437.4	RS Means - 03.11.13.65-1400
Place Rebar	136	Ea.	435	0.3126436782	10.99	1494.64	1.34	182.24	-	-	1676.88	RS Means - 03.21.10.60-2420
Pour Concrete	74	C.Y	56.4	1.312056738	169	12506	63.5	4699	0.42	31.08	17236.08	RS Means - 03.30.53.40-4050
Cour Concrete	-	-	-	7	-	-	-	-	-	-	0	-
Strip Forms	180	L.F.	4800	0.0375	0	0	0	0	0	0	0	Included in Place Forms Price
Backfill	1400	S.F.	6000	0.2333333333	38	53200	0.22	308	0.02	28	53536	RS Means - 31.23.23.17-0800
Total						138988.92		31558.66		25565.95	196113.53	