EARTH SCIENCE ENGINEERING, L.L.C.

Project no. 88246

Geotechnical Report
for the
proposed
Stupp Brothers Industrial Facility

prepared for

Hopkinsville-Christian County Economic Development

August 10, 1998

EARTH SCIENCE ENGINEERING, L.L.C.

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EARTH SCIENCE ENGINEERING, LLC

Monday, August 10, 1998

Ms. Kim Schippers
Hopkinsville-Christian County Economic Development
1209 South Virginia Street, P.O. Box 1382
Hopkinsville, KY 42241

RE: Prospective Stupp Brothers Industrial Facility
Hopkinsville, Kentucky
ESE Project no. 88246

Dear Ms. Schippers,

Earth Science Engineering, L.L.C. (ESE) is pleased to submit this Geotechnical Report for the proposed Stupp Brothers Industrial Facility planned in Hopkinsville, Kentucky. Included in the report are the results of the exploration and laboratory testing program, a description of the site conditions, and ESE's recommendations concerning foundations, site development, and new pavements. One copy of the report is attached.

Thank you for this opportunity to assist you with this project. ESE looks forward to assisting you as the project geotechnical engineer during the site development and foundation construction phases. If you have any questions concerning this report or if ESE may be of further service with other geotechnical investigations or environmental site assessment services, please do not hesitate to call.

Sincerely,

EARTH SCIENCE ENGINEERING, L.L.C.

Christopher K. Casteel, P.E.
Principal Engineer

cc: John Mann, P.E. (1 copy)
Woolpert, L.L.P.

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Proposed Stupp Brothers Industrial Facility
Hopkinsville, Kentucky

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INTRODUCTION

Authorization Earth Science Engineering, L.L.C. (ESE) has completed a subsurface exploration and geotechnical engineering study at the site of the new Stupp Brothers Industrial Facility to be constructed in Christian County, Kentucky. ESE's services were performed in accordance with ESE's July 14, 1998 proposal to Ms. Kim Schippers of Hopkinsville-Christian County Economic Development. Authorization for these services was provided to ESE in the form of verbal authorization provided by Ms. Schippers.

Purpose The purpose of this investigation was to obtain information regarding the site subsurface conditions and to formulate and present recommendations concerning site development, foundation design, and floor slab construction. The following paragraphs and attached appendices of this report contain ESE's findings, discussion of site conditions, and recommendations for foundations, and site development.

EXPLORATION AND TESTING

Scope ESE's scope of services for this project included a reconnaissance of the project site by a registered professional engineer, subsurface drilling and soil sampling, laboratory testing of soil samples, and presentation of recommendations regarding site development, footing design, and floor slab construction.

Field Borings Eleven soil borings were drilled within the area designated for proposed building construction at locations selected by representatives of Woolpert, L.L.P.. The borings were staked in the field via normal taping procedures based on a site topographic plan provided by Woolpert, L.L.P..

Surface elevations were approximated from the topographic site plan. The surface elevation of each individual boring was interpolated to the nearest foot from the five feet contours of the site plan. Each respective boring elevation is shown on the subsurface exploration logs in Appendix B.

Soil Drilling and Sampling The soil borings were performed with ESE's truck-mounted rotary drill rig, Model D-50, manufactured by Diedrich Drill, Inc. The borings were advanced with 2 1/4 inch I.D. hollow stem augers. Due to soft surficial soil conditions caused by recent heavy rainfall, dozer assistance was required for each boring to be accessed with the truck-mounted drill.

At preselected intervals throughout the boring depths, soil samples were recovered with a two inch O.D. split spoon sampler in accordance with the Standard Penetration Test (ASTM D 1586). The Standard Penetration Test consists of the measurement of the number of blows with a 140 pound hammer that is required to drive the split spoon sampler 6 inches into the soil. Typically, each test involves three 6 inch increments which comprise a total length of 18 or 24 inches. The values (blow counts) for the second and third increments are added together, designating the N-value for the respective soil sample.

During the field exploration, two undisturbed (Shelby tube) samples were obtained in accordance with ASTM D 1587. This sampling procedure consists of forcing a three inch diameter steel tube into the soil. The tube is carefully removed from the soil and sealed for transport to the laboratory for extrusion and testing.

Upon completion of augering, water level observations were made in all borings. Several borings were left open for a delayed time so that longer term water intrusion could be assessed. After these water level observations, the borings were then back filled with soil cuttings. It should be noted that, over time, the cuttings may settle and leave a void at the surface, requiring corrective measures by the Owner.

Laboratory Testing The soil samples recovered during the field exploration were transported to the ESE soils laboratory where they were examined and visually classified by a registered professional engineer. All soil samples were tested for natural moisture content (ASTM D 2216) and five select samples tested for Atterberg limits (ASTM D 4318). The undisturbed Shelby tube samples were tested for unconfined compressive strength (ASTM D 2166).

Additionally, unconfined compressive strengths were determined with the use of a RIMAC® field test device. The RIMAC® device consists of a calibrated spring apparatus which measures ultimate load to axial failure versus overall strain of the sample. Density measurements were performed on several of the RIMAC® test samples.

All laboratory testing results are shown on the subsurface exploration logs in Appendix B or the laboratory data sheets contained in Appendix C. It should be noted that transitions between the soil types can be more gradual than shown on the logs. Those portions of the samples not altered by testing will be retained for 60 days after submittal of this report, at which time they will be discarded unless ESE is instructed otherwise.

SITE CONDITIONS

Location The project site, a parcel of the Christian County Industrial Park site, is located northwest of the Highway 41 and Frank Yost Lane intersection (assuming Highway 41 runs north-south) in Christian County, Kentucky. The site is approximately two miles south of the Hopkinsville, Kentucky city limits and approximately two miles north of Pembroke, Kentucky.

Surface At the time of the field exploration, the majority of project site was observed to be covered by either short soybeans or mature corn at the northwest portion of the site (at borings H-1 and H-2). Areas limited to a swale at the southeast portion of the site and along the site west property line (at CSX Railroad) are wooded. With the exception of a small hunting cabin, no structures or signs of previous development were observed on the site.

Topography of the site appears to be gently rolling with overall drainage directed from the west towards a drainage swale at the southeast edge of the project site. According to topographic information provided to ESE, existing elevations within the proposed building area range from near elevation +660 at boring H-7 downward to near elevation +635 at borings H-3 and H-11.

Due to heavy rainfall at the time of the field exploration, accessing the boring locations with the truck mounted drilling equipment required dozer assistance.

Soil During the field exploration, topsoil measurements were estimated to range between 4 and 10 inches. However, due to the systematic cultivation practices experienced by the project site in the past, the estimated topsoil thicknesses should be considered very approximate. It should be noted that topsoil is identified as that portion of the surficial soils containing large quantities of roots and other organics. Brownish colored silty clay soil underlies the measured topsoil at many of the borings. In many instances, these soils also contained lesser quantities of small roots. Agricultural laboratory testing would be required to determine if these soils are indeed topsoil and to evaluate their characteristics for landscaping purposes.

The subsurface soils encountered in the 11 borings generally consist of low plasticity silty clay soils (at several borings) underlain by moderately to highly plastic clays. The low plasticity silty clays (Unified Soil Classification: CL) exhibited moderate strength, although lower strengths are present in the upper 5.5 feet of boring H-1, upper 3 feet of boring H-4, upper 3 feet of boring H-5, upper 5.5 feet of boring H-6, and upper 3 feet of boring H-8. Soils represented by these upper samples are brownish in color and contain significant silt concentrations.

At deeper depths of the borings and entire depths of other borings, moderately to highly plastic clays (Unified Soil Classification: CH, CL-CH, and CL) were. These soils exhibited moderate strength and are generally reddish tan in color. Many samples of the moderately to highly plastic clays contain trace amounts of sand and chert fragments.

Bedrock Auger or spoon refusal was encountered within all 11 of the borings drilled for this project. The refusal depths and corresponding elevations (shown to the nearest foot) are provided below:

Boring no.	Refusal depth	Refusal elevation (+/-)
H-1	13'2"	+ 629
H-2	13'6"	+ 632
H-3	12'	+ 624
H-4	13'6"	+ 629
H-5	15'6"	+ 622
H-6	16'4"	+ 622
H-7	12'4"	+ 646
H-8	22'9"	+ 619
H-9	7'9"	+ 636
H-10	5'10"	+ 645
H-11	8'4"	+ 628

Groundwater During augering, no free water was observed in any of the 11 borings. Immediately after completion of augering, each bore hole was checked for water with none being observed. Several borings were left open for a delayed time period, after which they were again checked for water. Water was only present at a depth of 15' 1" at boring H-5.

Due to the depths of the borings and their absence or extensive depth of water (at boring H-5), it is not anticipated that groundwater will influence shallow excavation operations at the project site. The installation and periodic monitoring of several piezometers would be required to better ascertain fluctuations of site groundwater levels.

Site Geology According to the Hopkinsville Quadrangle Geologic Map published by the Kentucky Geological Survey, the project site is located within the Renault Limestone formation of the Mississippian Age.

The Renault Limestone formation is typically very light to medium gray, fine to medium grained, thin to thick bedded limestone. In the general project area, this limestone is found at the base of a zone of yellowish-gray residual soil containing small pellets of iron oxide nodules.

PROJECT INFORMATION AND REQUIREMENTS

According to information provided by Ms. Kim Schippers of Hopkinsville-Christian County Economic Development and Messieurs John Mann, P.E. and Ben Coomes, P.E. of Woolpert, L.L.P., it is understood that the project will be built generally northwest of the new Continental Mills Facility. The new facility will be "H" shaped and will encompass a plan area on the order of 360,000 square feet.

At this time, detailed structural loading and site grading information has not been provided. For the purpose of this report, maximum column loads of 80 kips and wall loads of 3.5 kips per linear foot of wall are assumed. Site grading information has yet to be finalized, however, based on observation of the site topographic information, maximum cut and fill depths of up to 25 feet may be required to achieve design subgrade. No below ground construction is planned to our knowledge.

As is the case of all construction projects, the outlined project information is subject to change. If any of the above information should change significantly or be in error, ESE should be notified so that our recommendations can be reviewed and revised, if necessary.

GEOTECHNICAL RECOMMENDATIONS

General Based on the field and laboratory test results, the subsurface soils at the site generally exhibit moderate strength and low to high plasticity. In consideration of the site soils and project requirements, it is possible to select a system of moderately loaded shallow spread and strip footings bearing on the stiff or stronger site soils or compacted structural fill for structural support of the proposed construction.

The brownish low plasticity silty clay soils encountered within the upper 3 to 5.5 feet of borings H-1, H-4, H-5, H-6, and H-8, due to their relatively low strength and compressible nature, are not recommended for direct support of building footings and floor slabs. Due to the soils' low strength and potential for building settlement, it may be necessary to excavate the soils from the building area (and at least five feet beyond the building perimeter) and replace them with compacted structural fill (commonly referred to as undercutting).

The presence of these unsuitable soils in the borings may indicate the presence of one or more pockets of this undesirable soil in other areas of the proposed project, including the building area. The condition of the site soils can be better evaluated via proof rolling techniques after stripping and cutting to the desired subgrade level. Proof rolling is discussed in more detail in the following Grading section of this report.

The presence of highly plastic clays at the borings also warrants consideration. Highly plastic clays can undergo significant volumetric changes (swelling) as their moisture contents change. Areas of the country with very wet seasons and extended dry periods find these soils more problematic than areas with less extreme weather. If the volumetric changes are severe enough, structures supported by the clays can be impacted, resulting in deformation and cracking. The swell potential of the clays at this site is reduced by the depth, in addition to the granular content, of the soils. Foundation systems, such as drilled, cast-in-place caissons, which bear at depths less affected by surface moisture variations help to minimize the risk associated with swelling clays. Additionally, the threat of the volumetric changes can be reduced by either keeping the clay moisture content generally constant or by lowering the plasticity of the clay (i.e. lime stabilization). However, given that area footing foundation systems bearing on similar soils have performed satisfactorily in the past and the additional project cost associated with drilled caissons or lime stabilization procedures, it appears as though a shallow footing foundation system bearing on the site clays will be the most practical and economically feasible method of structural support.

Recommendations for site grading, footings, floor slabs, and wall design are presented in the following sections of this report.

Grading Prior to construction, utilities in the project area should be identified, adequately marked, and relocated as necessary. All surficial vegetation and topsoil should be stripped from the area designated for construction and stockpiled for later use as landscaping material. The building area should be cut, as necessary, to the desired subgrade level.

Before placement of any structural fill and prior to footing construction, the entire building area (and drive/parking areas) designated for fill placement should be proof rolled as practically possible with a fully loaded rubber tired dump truck under the direction of a Geotechnical Engineer. Based on observations made during proof rolling, it may become necessary to excavate several shallow back hoe test pits for additional observations or perform localized undercutting in which unsuitable soils are excavated from the subgrade and replaced with compacted structural fill. After the filled portions of the project are completed and the remaining cut areas have been cut to subgrade elevation, the cut areas should then be proof rolled with a loaded dump truck also. During this proof rolling process, special attention should be paid to the vicinity of borings H-1, H-4, H-5, H-6, and H-8

It is recommended that structural fill be placed in nine inch or thinner loose lifts and be compacted to no less than 98 percent of the Standard Proctor maximum dry density (ASTM D 698) at moisture contents within 2 percent of the optimum value. It is also recommended that fill compaction verification be performed at a rate of not less than one test per 25,000 square feet for each nine inch loose lift of fill in the building area. Structural fill should be free of organic or other deleterious materials and have a maximum particle size less than two inches. Structural fill obtained from off-site sources should have a PI between 15 and 28. Variations of the structural fill properties may be permitted after review and approval by ESE.

The majority of the on-site soils (not the brownish silty clays represented by borings H-1, H-4, H-5, H-6, and H-8) which are free of any organics may be used as structural fill. Due to the moisture contents of these soils being potentially higher than what would typically be the soils' optimum moisture content(s), aeration and/or additional compactive effort of the excavated soils will likely be required before the recommended compaction can be achieved.

Footing Construction Exterior building footings should be constructed 18 inches (minimum) below final exterior grade. Interior building footings may be constructed at a minimum depth of 12 inches below subgrade provided they bear on the recommended soils which have not been displaced by construction traffic.

Column and strip footings bearing on a combination of the stiff reddish brown site clays (not the brownish silty clays represented by borings H-1, H-4, H-5, H-6, and H-8) or structural fill which has been placed and compacted as directed in the "Grading" section of this report, can be designed for maximum soil bearing pressures of up to 3,000 psf and 2,500 psf, respectively, based on dead load plus design live load. In order to reduce potential for differential settlements, it is recommended that, as practically possible, all column footings be designed at the same allowable column bearing pressure and all wall footings be designed at the same allowable wall bearing pressure.

Due to the potential for isolated, soft soil zones at the site, it is recommended that all footing excavations be inspected by a Geotechnical Engineer to verify the condition of the bearing soils. Any unstable pockets within the footings should be excavated to a depth and extent determined by the Engineer and back filled with concrete, Engineer approved granular fill, or compacted structural fill.

It is recommended that footings be concreted the same day they are opened to limit drying and shrinkage of the footing bearing surface and difficulties associated by surface runoff entering the excavations during precipitation events. If it is necessary to leave footings open overnight, they should be covered and the ground surface along the sides of the footings sloped away from the inside of the footing excavation. Footings should not be placed in standing water or on frozen ground. The bearing surface of the footings should be cleaned of loose soil which may have been disturbed during excavation or sloughed during reinforcing steel placement.

Spread footings should have a minimum plan dimension of 30 inches and strip footings should have a minimum width of 18 inches, even if the bearing pressures are less than the recommended values. Structural design of the footings should be performed by a structural engineer and should meet local building code requirements. All footing excavations should follow applicable OSHA trenching guidelines.

Based on past experience with similar soils, footings which are constructed on the recommended soils and are fully loaded to the maximum expected structural loading at the recommended bearing pressures can be expected to experience total settlements less than 1 inch. Differential settlements can be expected to be approximately one half of the total settlement.

Floor Slab Construction Structural slabs with a "crawl space" or floor slabs supported by soils which have been proof rolled and filled as recommended in the "Grading" section of this report may be used for the new building. Supporting floor slabs upon the brown and gray silty clays represented by the upper two feet of the borings is not recommended. Based on past experience with similar soils, a subgrade modulus no greater than 120 pci should be used for soil-supported slab design.

It is recommended that a layer of crushed stone (no. 57 or similar) be placed beneath the soil-supported floor slab to enhance drainage and provide a uniform bearing surface for the floor slab concrete. The thickness of the crushed stone layer is dependent upon the anticipated slab loading conditions and preference of the structural designer. However, ESE recommends that the layer be no less than six inches in thickness. Polyethylene sheeting should be placed beneath the floor slab to act as a moisture vapor barrier. The floor slab should have an adequate number of expansion joints and, where practical, should not be rigidly connected to foundations, walls, or columns.

Wall Design In order to facilitate drainage behind retaining and basement walls, minimize potential disturbance due to over compaction of fine-grained back fill soil, and reduce potential difficulties associated with the subsurface water at the site, it is recommended that all back fill material for on-site walls be a free draining granular material with minimal fines (less than 15%). As a minimum, the zone of back fill should extend from the heel of the wall footing and slope at an angle of 60 degrees from the horizontal. The upper three feet of back fill should consist of a relatively low permeability fine-grained soil to minimize surface water infiltration. The placement of a filter fabric between the fine-grained soil and the granular material to prevent segregation of the fine-grained particles into the granular back fill is advised. A perimeter drainage system, either gravity flow or a sump system with pumps, is recommended.

For design purposes, the unit weight of the granular back fill material can be taken as 135 pounds per cubic foot (pcf) or as determined by laboratory testing. Given that design of retaining walls can experience movement at the top (active condition), retaining wall design may be performed using a drained, moist equivalent fluid pressure of 34 pcf, provided adequate drainage of the back fill is provided. Any basement or pit walls, being fixed at the top, should be designed for the at-rest condition with a drained, moist equivalent fluid pressure of 55 pcf. If back fill drainage is not provided, the equivalent fluid pressures should be increased; however, constructing walls without back fill drainage is not recommended. Surcharge loading, due to vehicles, construction equipment, etc., should be included in the design procedure as required.

OTHER CONSIDERATIONS

Sinkholes Bedrock in the project area is susceptible to solutioning and sinkhole formation. Sinkholes typically occur due to collapse of subsoil caused by fluctuating groundwater levels. Groundwater can be influenced by a multitude of factors including precipitation variations and changes in surface drainage patterns. Sinkholes and associated solution features are not always visible from the ground surface, requiring elaborate subsurface investigation methods for detection.

One area, southeast of the building area, was observed to be covered in thick vegetation, indicating the possible, but not confirmed, presence of a potential sinkhole near the site. Although no obvious sinkhole conditions were observed at the project site, the risk of future sinkhole development is a risk builders and owners assume when building in the general project area. Treatment of any on-site sinkholes should be performed in accordance with applicable State and Federal regulations. If voids are discovered during site grading, ESE should be contacted for recommendations regarding sinkhole repair.

Weather The soils which were encountered at the project site are sensitive to changes in their moisture content and disturbances by construction equipment. More soil related difficulties can be expected during or after significant rain events than after extended periods of dry weather. Proper site development planning on the part of the owner, project designers, and contractor(s) should be conducted in order to minimize weather aggravated soil problems.

Seismic Coefficients According to figures 1607.1.5A and 1607.1.5B of the 1994 edition of the *Standard Building Code*, the site falls into zones with an effective peak velocity-related acceleration coefficient, A_v, of 0.05 and a peak acceleration coefficient, A_a, of 0.05, respectively. Based on the subsurface information obtained from the borings, it appears as though the project site can be classified as type S_1 with a S factor of 1.0 according to Table 1607.3.1 of the *Standard Building Code*.

Relatively fine, clean cohesionless sands are believed to be the soil types most susceptible to liquefaction during seismic events. Cohesive clays and silts are less susceptible to liquefaction. Additionally, a relatively high groundwater table increases the potential liquefaction. Given that the soils in the borings consist of clays and no significant water was encountered, it appears as though the site soils in the upper do not exhibit a high potential for liquefaction.

Project Specifications Specifications for this project should meet local building codes and OSHA guidelines. The observations, recommendations, and considerations presented in this report should be fully read and understood by the owner, project designer(s), and contractor(s) prior to final submittal of project plans and specifications. Once the plans and specifications are more complete, ESE should be retained to review the final design in order to verify that our recommendations have been interpreted properly.

Construction Monitoring The implementation of a soil and concrete quality testing program aids in assuring that the end product is that which was designed. Thorough testing also allows opportunity for correction before major problems develop. For these reasons, ESE recommends the retainage of a qualified testing laboratory (by the Owner) to conduct quality tests on structural fill, aggregate base course, concrete, asphalt paving, and crushed stone fill (if used). ESE would be happy to assist in this process by reviewing testing laboratory qualifications for selection purposes, conducting site subgrade and foundation testing/observations, and evaluating field and laboratory test reports for compliance with project requirements.

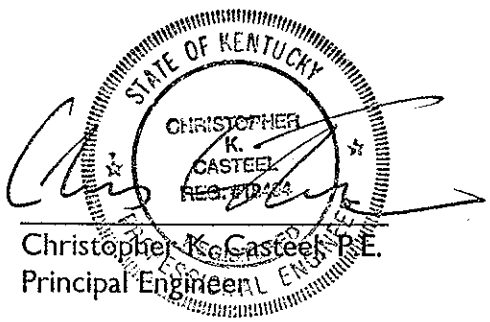
Limitations The recommendations presented in this report are derived from the soils encountered in the borings and information provided by Hopkinsville-Christian County Economic Development and Woolpert, L.L.P.. Should conditions during site development and construction activities differ from those discussed in this report, ESE should be contacted so that our recommendations can be reviewed and revised, if necessary.

ESE's scope of services did not include any environmental assessment for the presence or absence of hazardous or toxic materials in the soil or groundwater at or adjacent to the site studied. Additionally, ESE's services did not include the verification or delineation of any potential wetlands at the site. Any statements in this report or on the subsurface exploration logs concerning soil odors, colors, or other unusual conditions are strictly for the information of the client. Prior to purchase or development of this site, a thorough environmental assessment is recommended.

This report has been prepared for the exclusive use of Hopkinsville-Christian County Economic Development in reference to the proposed Stupp Brothers Industrial Facility to be built in Christian County, Kentucky.

Respectfully submitted,

EARTH SCIENCE ENGINEERING, L.L.C.



Christopher K. Casteel, P.E.
Principal Engineer

Attachments: Appendices

Appendix A

Boring Location Plan

Appendix B

Subsurface Exploration Logs

KEY TO BORING LOG SYMBOLS

DRILLING AND SAMPLING SYMBOLS

SS: Split-spoon; 1 3/8" I.D., 2" O.D.

ST: Shelby tube; 3" O.D.

AU: Auger bag sample

DB: Diamond bit (rock coring)

SOIL PROPERTY SYMBOLS

Qp: Unconfined compressive strength, hand penetrometer, tsf

N: Blows per foot of a 140 lb hammer falling 30 inches on a 2" O.D. split spoon

mc: Percent of water in sample, %

Dd: Sample dry density, pcf

-#200: Percent of sample passing a #200 sieve

Qu: Unconfined compressive strength, Shelby tube sample

Q_R: Unconfined compressive strength, RIMAC® field test device, tsf

LL: Liquid limit, %

PI: Plasticity Index

-#4: Percent of sample passing a #4 sieve

RELATIVE DENSITY AND CONSISTENCY

COHESIVE SOILS (clays & silts)

N	Consistency	Qu (tsf)
0 - 2	Very soft	0 - 0.25
3 - 4	Soft	0.25 - 0.50
5 - 8	Firm	0.50 - 1.00
9 - 15	Stiff	1.00 - 2.00
16 - 30	Very stiff	2.00 - 4.00
> 30	Hard	> 4.00

NON-COHESIVE SOILS (sands & gravels)

N	Relative Density
0 - 4	Very loose
5 - 10	Loose
11 - 30	Medium Dense
31 - 50	Dense
> 50	Very Dense

PARTICLE SIZE

Boulders > 8"

Cobbles 3" - 8"

Gravel 5mm - 3"

Coarse sand 0.6mm - 5mm

Medium sand 0.2mm - 0.6mm

Fine sand 0.074mm - 0.2mm

Silt 0.005mm - 0.074mm

Clay < 0.005mm

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SUBSURFACE EXPLORATION LOG, Boring no.: H-1

Stupp Brothers Industrial Facility
Hopkinsville-Christian County Ind. Park

ESE project no.: 88246

Date Started	: 07/16/98	Driller	: B. Currie
Date Completed	: 07/16/98	Helper	: C. Leffel
Hole Diameter	: 6 1/4 in.	Drill Equipment	: Diedrich D-50
Drilling Method	: H.S.A.	Estimated topsoil depth: 5"	
Sampling Method	: SPT; Automatic Hammer	Elevations provided by Woolpert, L.L.P.	

Sample Type
- Split spoon
- Shelby tube
- Auger cuttings
- Rock core

Depth in Feet	Surf. Elev. 642	Samples	DESCRIPTION	USCS	GRAPHIC	N-value (blows per foot) 0 5 10 15 20	Qp (tsf) 0 1 2 3 4 5	mc (%) 15 20 25 30	Qr (tsf)	Dd (pcf)
0	642									
			Soft brown changing to tannish brown silty CLAY	CL					0.9	99
			LL=31, PI=14 (at 3.5')						0.8	91
5	637									
			Stiff tannish brown & gray changing to grayish tan CLAY						1.8	103
			LL=34, PI=18 (at 6')	CL-CH					2.4	105
10	632									
			Boring terminated @ 13'2" due to auger refusal.							
15	627									
20										

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SUBSURFACE EXPLORATION LOG, Boring no.: H-2

Stupp Brothers Industrial Facility
Hopkinsville-Christian County Ind. Park

ESE project no.: 88246

Date Started	: 07/16/98	Driller	: B. Currie
Date Completed	: 07/16/98	Helper	: C. Leffel
Hole Diameter	: 6 1/4 in.	Drill Equipment	: Diedrich D-50
Drilling Method	: H.S.A.	Estimated topsoil depth: 4"	
Sampling Method	: SPT; Automatic Hammer	Elevations provided by Woolpert, L.L.P.	

Sample Type
- Split spoon
- Shelby tube
- Auger cuttings
- Rock core

Depth in Feet	Surf. Elev. 646	Samples	DESCRIPTION	USCS	GRAPHIC	N-value (blows per foot) 0 5 10 15 20	Qp (tsf) 0 2 4 6	mc (%) 15 20 25 30	Qr (tsf)	Dd (pcf)
0	646									
			Stiff tannish brown silty CLAY with trace of small roots	CL						
			Very stiff grayish red CLAY	CL-CH					3.9	111
5	641									
			Very stiff tannish brown CLAY, fat	CH					5.5	94
10	636									
			Boring terminated @ 13'6" due to auger refusal.							
15	631									
20										

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SUBSURFACE EXPLORATION LOG, Boring no.: H-3

Stupp Brothers Industrial Facility
Hopkinsville-Christian County Ind. Park

ESE project no.: 88246

Date Started	: 07/16/98	Driller	: B. Currie
Date Completed	: 07/16/98	Helper	: C. Leffel
Hole Diameter	: 6 1/4 in.	Drill Equipment	: Diedrich D-50
Drilling Method	: H.S.A.	Estimated topsoil depth: No reading	
Sampling Method	: SPT; Automatic Hammer	Elevations provided by Woolpert, L.L.P.	

Sample Type: Split spoon; Shelby tube; Auger cuttings; Rock core

Depth in Feet	Surf. Elev. 636	Samples	DESCRIPTION	USCS	GRAPHIC	N-value (blows per foot) 0 5 10 15	Qp (tsf) 0 2 4 6	mc (%) 15 20 25	Qr (tsf)	Dd (pcf)
0	636									
			Firm grayish brown silty CLAY	CL						
			Stiff grayish tan with red CLAY with trace of ferrous oxide	CL-CH					2.9	108
5	631									
			more ferrous oxide @ 8.5'						2.9	103
10	626									
			Boring terminated @ 12' due to auger refusal.							
15	621									
20										

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EARTH SCIENCE ENGINEERING, L.L.C.
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SUBSURFACE EXPLORATION LOG, Boring no.: H-4

Stupp Brothers Industrial Facility
Hopkinsville-Christian County Ind. Park

ESE project no.: 88246

Date Started	: 07/15/98	Driller	: B. Currie
Date Completed	: 07/15/98	Helper	: C. Leffel
Hole Diameter	: 6 1/4 in.	Drill Equipment	: Diedrich D-50
Drilling Method	: H.S.A.	Estimated topsoil depth: 10"	
Sampling Method	: SPT; Automatic Hammer	Elevations provided by Woolpert, L.L.P.	

Sample Type
- Split spoon
- Shelby tube
- Auger cuttings
- Rock core

Depth in Feet	Surf. Elev. 643	Samples	DESCRIPTION	USCS	GRAPHIC	N-value (blows per foot) 0 5 10 15	Qp (tsf) 0 1 2 3 4 5	mc (%) 15 20 25 30	Qr (tsf)	Dd (pcf)
0	643									
			Soft brown silty CLAY	CL					1.1	98
			Firm reddish brown silty CLAY	CL						
5	638		LL=37, PI=18 (at 3.5')							
			Stiff reddish tan CLAY	CL-CH					1.5	107
10	633									
			Spoon refusal @ 13.5'							
15	628		After being left open in excess of 48 hours, the borehole was dry and had caved at a depth of 13.2'.							
20										

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SUBSURFACE EXPLORATION LOG, Boring no.: H-5

Stupp Brothers Industrial Facility
Hopkinsville-Christian County Ind. Park

ESE project no.: 88246

Date Started	: 07/16/98	Driller	: B. Currie
Date Completed	: 07/16/98	Helper	: C. Leffel
Hole Diameter	: 6 1/4 in.	Drill Equipment	: Diedrich D-50
Drilling Method	: H.S.A.	Estimated topsoil depth: 6"	
Sampling Method	: SPT; Automatic Hammer	Elevations provided by Woolpert, L.L.P.	

Sample Type
- Split spoon
- Shelby tube
- Auger cuttings
- Rock core

Depth in Feet	Surf. Elev. 638	Samples	DESCRIPTION	USCS	GRAPHIC	N-value (blows per foot) 0 5 10 15 20	Qp (tsf) 0 1 2 3 4 5	mc (%) 15 20 25 30	Qr (tsf)	Dd (pcf)
0	638		Soft brown silty CLAY with small roots	CL					1.2	95
			Qu: 2.7 ksf, Dd: 103.3 psf							
5	633		Stiff tannish brown with red CLAY with trace of ferrous oxide	CL-CH					10	109
10	628									
			Qu: 4.0 ksf, Dd: 100.3 psf							
15	623		Boring terminated @ 15'6" due to auger refusal.							
20										

After being left open in excess of 48 hours, water was at a depth of 15.1'. The bore hole had caved at a depth of 15.3'.

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SUBSURFACE EXPLORATION LOG, Boring no.: H-6

Stupp Brothers Industrial Facility
Hopkinsville-Christian County Ind. Park

ESE project no.: 88246

Date Started	: 07/16/98	Driller	: B. Currie
Date Completed	: 07/16/98	Helper	: C. Leffel
Hole Diameter	: 6 1/4 in.	Drill Equipment	: Diedrich D-50
Drilling Method	: H.S.A.	Estimated topsoil depth: 8"	
Sampling Method	: SPT; Automatic Hammer	Elevations provided by Woolpert, L.L.P.	

Sample Type
- Split spoon
- Shelby tube
- Auger cuttings
- Rock core

Depth in Feet	Surf. Elev. 638	Samples	DESCRIPTION	USCS	GRAPHIC	N-value (blows per foot) 0 5 10 15	Qp (tsf) 0 1 2 3	mc (%) 15 20 25 30 35	Qr (tsf)	Dd (pcf)
0	638		Very soft dark brown silty CLAY	CL						
			LL=40, PI=23 (at 3.5')						1.6	94
5	633		Firm brown silty CLAY, slightly red at 6'	CL					2.0	100
									2.8	99
10	628		Stiff to firm reddish tan changing to brownish tan CLAY, fat	CH						
15	623									
20			Boring terminated @ 16'4" due to auger refusal.							

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SUBSURFACE EXPLORATION LOG, Boring no.: H-7

Stupp Brothers Industrial Facility
Hopkinsville-Christian County Ind. Park

ESE project no.: 88246

Date Started	: 07/15/98	Driller	: B. Currie
Date Completed	: 07/15/98	Helper	: C. Leffel
Hole Diameter	: 6 1/4 in.	Drill Equipment	: Diedrich D-50
Drilling Method	: H.S.A.	Estimated topsoil depth: 7"	
Sampling Method	: SPT; Automatic Hammer	Elevations provided by Woolpert, L.L.P.	

Sample Type
- Split spoon
- Shelby tube
- Auger cuttings
- Rock core

Depth in Feet	Surf. Elev. 658	Samples	DESCRIPTION	USCS	GRAPHIC	N-value (blows per foot) 0 5 10 15	Qp (tsf) 0 1 2 3 4 5 6	mc (%) 15 20 25 30	Qr (tsf)	Dd (pcf)
0	658									
			Firm to stiff reddish brown with tan CLAY	CL-CH					3.0	97
			with gray color and trace of sand @ 3.5'						2.2	103
5	653									
			and							
			with ferrous oxide @ 8.5'						4.0	104
10	648									
			Boring terminated @ 12'4" due to auger refusal.							
15	643									
20										

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SUBSURFACE EXPLORATION LOG, Boring no.: H-8

Stupp Brothers Industrial Facility
Hopkinsville-Christian County Ind. Park.

ESE project no.: 88246

Date Started	: 07/15/98	Driller	: B. Currie
Date Completed	: 07/15/98	Helper	: C. Leffel
Hole Diameter	: 6 1/4 in.	Drill Equipment	: Diedrich D-50
Drilling Method	: H.S.A.	Estimated topsoil depth: 5"	
Sampling Method	: SPT; Automatic Hammer.	Elevations provided by Woolpert, L.L.P.	

Sample Type
- Split spoon
- Shelby tube
- Auger cuttings
- Rock core

Depth in Feet	Surf. Elev. 642	Samples	DESCRIPTION	USCS	GRAPHIC	N-value (blows per foot) 0 5 10 15 20	Qp (tsf) 0 1 2 3 4 5 6	mc (%) 15 20 25 30 35	Qr (tsf)	Dd (pcf)
0	642									
			Firm brown silty CLAY with small roots	CL						
			Stiff to very stiff reddish brown with tan CLAY	CL-CH					3.5	105
5	637									
									4.4	110
10	632									
			LL=78, PI=48 (at 13.5')	CH					2.9	82
15	627		Stiff reddish tan CLAY, fat							
			less red color @ 18.5'						3.1	102
20	622									
25			Boring terminated @ 22'9" due to auger refusal.							

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SUBSURFACE EXPLORATION LOG, Boring no.: H-9

Stupp Brothers Industrial Facility
Hopkinsville-Christian County Ind. Park

ESE project no.: 88246

Date Started	: 07/16/98	Driller	: B. Currie
Date Completed	: 07/16/98	Helper	: C. Leffel
Hole Diameter	: 6 1/4 in.	Drill Equipment	: Diedrich D-50
Drilling Method	: H.S.A.	Estimated topsoil depth: 7"	
Sampling Method	: SPT; Automatic Hammer	Elevations provided by Woolpert, L.L.P.	

Sample Type
- Split spoon
- Shelby tube
- Auger cuttings
- Rock core

Depth in Feet	Surf. Elev. 644	Samples	DESCRIPTION	USCS	GRAPHIC	N-value (blows per foot) 0 5 10 15	Qp (tsf) 0 1 2 3 4	mc (%) 15 20 25 30 35	Qr (tsf)	Dd (pcf)
0	644									
			Firm reddish brown with tan CLAY	CL						
			LL=77, PI=51 (at 3.5')						2.9	90
5	639		Firm tannish red CLAY, fat	CH						
			Boring terminated @ 7'9" due to auger refusal.							
10	634									
15	629									
20										

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SUBSURFACE EXPLORATION LOG, Boring no.: H-10

Stupp Brothers Industrial Facility
Hopkinsville-Christian County Ind. Park

ESE project no.: 88246

Date Started	: 07/15/98	Driller	: B. Currie
Date Completed	: 07/15/98	Helper	: C. Leffel
Hole Diameter	: 6 1/4 in.	Drill Equipment	: Diedrich D-50
Drilling Method	: H.S.A.	Estimated topsoil depth: 6"	
Sampling Method	: SPT; Automatic Hammer	Elevations provided by Woolpert, L.L.P.	

Sample Type
- Split spoon
- Shelby tube
- Auger cuttings
- Rock core

Depth in Feet	Surf. Elev. 651	Samples	DESCRIPTION	USCS	GRAPHIC	N-value (blows per foot) 0 5 10 15 20	Qp (tsf) 0 1 2 3 4	mc (%) 15 20 25 30 35	Qr (tsf)	Dd (pcf)
0	651									
			Firm tannish gray CLAY	CL-CH						
				CH					1.4	76
5	646									
10	641									
15	636									
20										

Boring terminated @ 5'10" due to auger refusal.

After being left open in excess of 48 hours, the bore hole was dry and had caved at a depth of 3.3'.

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SUBSURFACE EXPLORATION LOG, Boring no.: H-11

Stupp Brothers Industrial Facility
Hopkinsville-Christian County Ind. Park

ESE project no.: 88246

Date Started	: 07/15/98	Driller	: B. Currie
Date Completed	: 07/15/98	Helper	: C. Leffel
Hole Diameter	: 6 1/4 in.	Drill Equipment	: Diedrich D-50
Drilling Method	: H.S.A.	Estimated topsoil depth: 6"	
Sampling Method	: SPT; Automatic Hammer	Elevations provided by Woolpert, L.L.P.	

Sample Type
- Split spoon
- Shelby tube
- Auger cuttings
- Rock core

Depth in Feet	Surf. Elev. 636	Samples	DESCRIPTION	USCS	GRAPHIC	N-value (blows per foot) 0 5 10 15	Qp (tsf) 0 1 2 3 4 5	mc (%) 20 25 30	Qr (tsf)	Dd (pcf)
0	636									
			Firm reddish brown with tan CLAY	CH					2.6	92
5	631		fat @ 3.5'						2.7	96
			Boring terminated @ 8'4" due to auger refusal.							
10	626		After being left open in excess of 48 hours, the bore hole was dry and had caved at a depth of 7.4'.							
15	621									
20										

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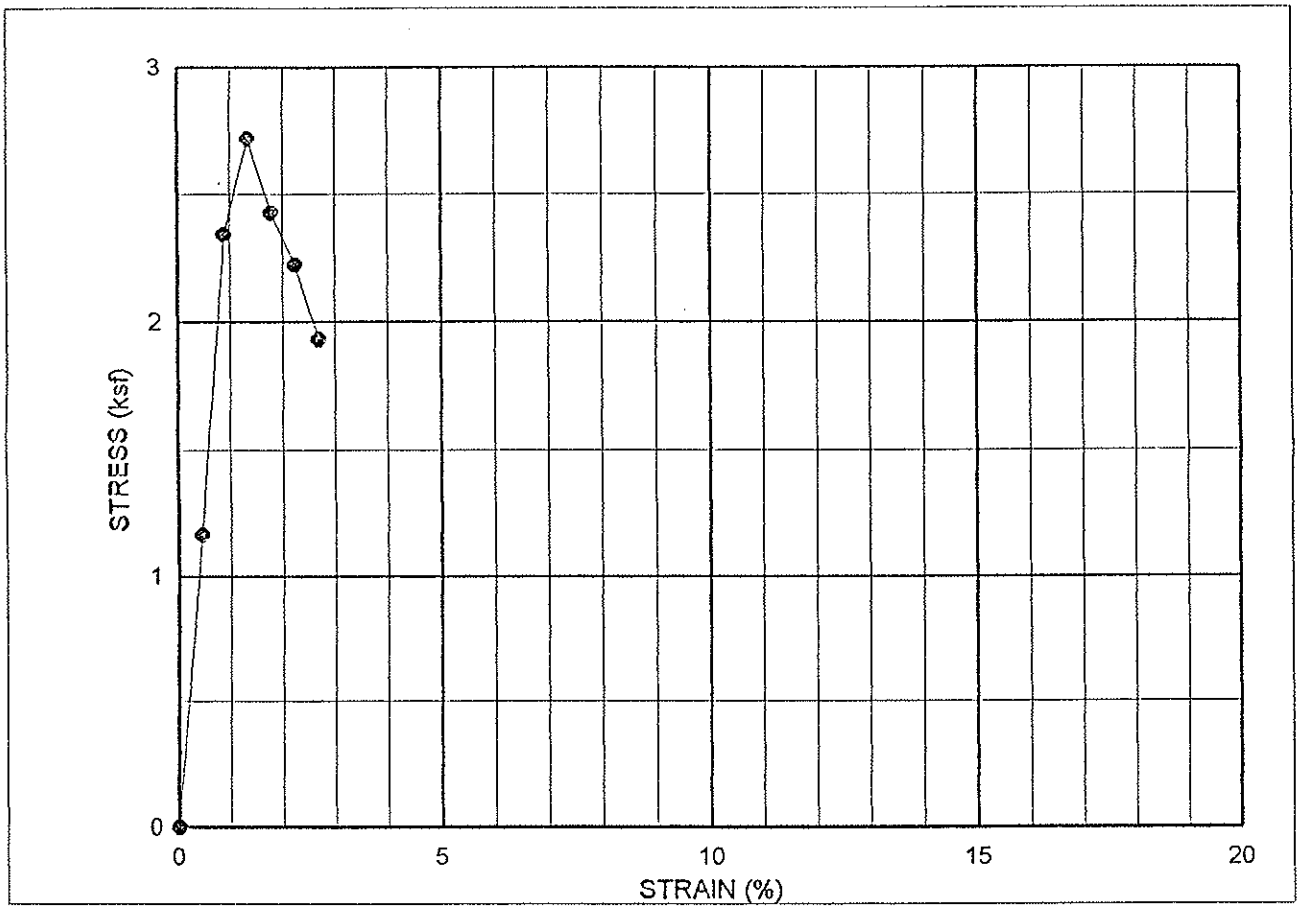
Appendix C

Laboratory Data Sheets

Unconfined Compressive Strength of Cohesive Soil

(ASTM D2166)



Project Name:
Client:
Project No.:
Boring No.: H-5,
Depth (ft): 3.5-5.0
Sample Type : undisturbed

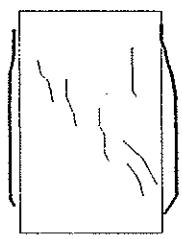
Moisture Content (%): 20.8
Dry Density (pcf): 103.3
Specimen Height (in.) : 5.60
Specimen Diameter (in.) 2.87
Height / Diameter Ratio : 1.95

Sample Description: SILTY CLAY w/ fine sand traces, ferrous oxide nodules, greyish red brown

Unconfined Compressive Strength (ksf) : 2.7

Max. Stress (ksf): 2.72
Shear Stress (ksf): 1.36
Strain at Failure (%): 1.3
Strain Rate (%/min.): 1.3

Failure Sketch



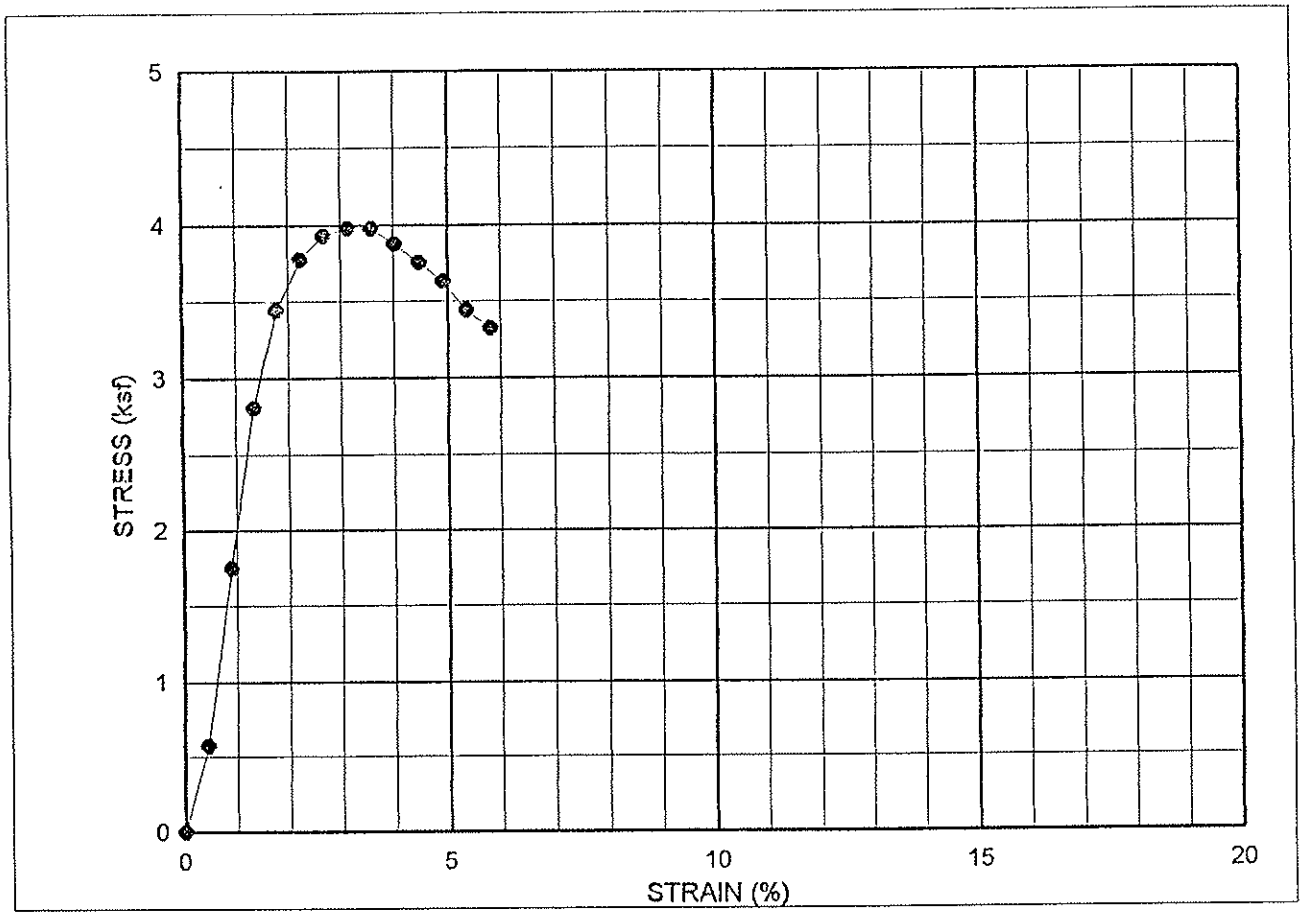
Comments: N/A

Tested By: Milton
Date: 07/22/98

Figure No.:

Unconfined Compressive Strength of Cohesive Soil

(ASTM D2166)



Project Name:
Client:
Project No.:
Boring No.: H-5,
Depth (ft): 13.5-15.0
Sample Type : undisturbed

Moisture Content (%): 24.6
Dry Density (pcf): 100.3
Specimen Height (in.) : 5.60
Specimen Diameter (in.) 2.87
Height / Diameter Ratio : 1.95

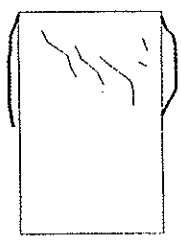
Sample Description: SILTY CLAY w/ chert, fine sand traces, ferrous oxide nodules, grey and red brown

Unconfined Compressive Strength (ksf) : 4.0

Max. Stress (ksf): 3.98
Shear Stress (ksf): 1.99
Strain at Failure (%): 3.6
Strain Rate (%/min.): 1.5

Comments: N/A

Failure Sketch



Tested By: Milton
Date: 07/22/98

Figure No.: