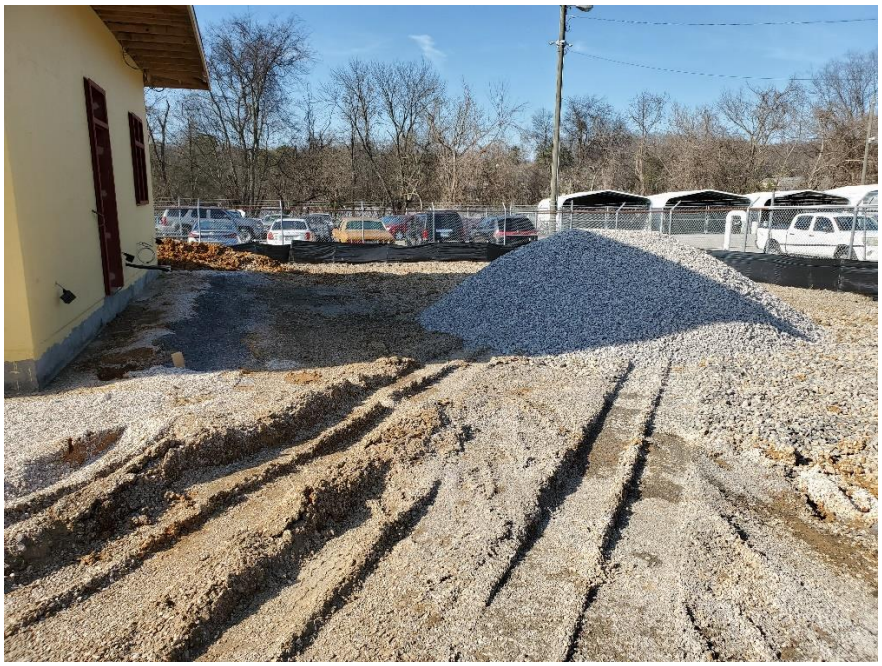

New Pavement & Pavement Overlay

Vehicle Impound Building
City of Knoxville
3403 Vice Mayor Jack Sharp Road
Knoxville, Tennessee

02/18/2019

FSE Project No. 320115

Prepared For: Ms. Amanda O. Koenig, P.E. – City of Knoxville

Foundation Systems Engineering, P.C.
Geotechnical Engineering and Consulting

February 18, 2020

Ms. Amanda O. Koenig, P.E.
City of Knoxville
Engineering Department
3131 Morris Avenue
Knoxville, TN 37909

Email: aokoenig@knoxvilletn.gov

RE: New Pavement Around Impound Building
New Pavement Overlay
Knoxville, TN
FSE Project No. 320115

Dear Ms. Koenig:

As per your authorization, we have completed a review of the subsurface exploration performed for the reference Impound Building in December 2017 and of the proposed traffic loading. Based on this information and our engineering analysis using this existing data, we offer the following engineering recommendations for both new pavements (within the area where the existing pavement is to be removed and replaced), and pavement overlay, thickness.

Please give us a call if you have any questions regarding our geotechnical report or if we may be of further service. It has been a pleasure to be of service on this portion of the project.

Sincerely,
Foundation Systems Engineering, P.C.

Jordan C. Hicks, M.S., E.I.
Geotechnical Engineering Associate

JACK F. LLEWELLYN, JR. REGISTERED ENGINEER AGRICULTURAL COMMERCIAL No. 19187 STATE OF TENNESSEE 02/18/2020

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1.0 EXECUTIVE SUMMARY

The proposed new City of Knoxville Impound Building is located at 3403 Vice Mayor Jack Sharp Road in Knoxville, Tennessee. At present, the building is under construction. The property is located on the north side of Vice Mayor Jack Sharp Road, approximately 1,500 feet southwest of the intersection of Vice Mayor Jack Sharp Road and Prosser road.

An area surrounding the building has had the existing asphalt removed. Appearances are that the area of proposed new pavement will extend a bit further toward Vice Mayor Jack Sharp Road than has currently been excavated. We observed some areas where the existing base has been contaminated with clay fill. We also observed an area where the base is pumping and rutting under construction traffic. Borings previously identified the soil beneath the existing pavement as very loose to loose (very soft to soft) very moist, organic silty clay fill mixed with trash and rubble.

The paved area scheduled for new asphalt overlay is covered with dirt and gravel. A thorough pavement condition survey was, therefore, not possible. We observed some cracking and some wet areas. We believe that the pavement has had one or more overlays during the past and has been subjected in the past primarily to light-duty traffic (parking of impounded vehicles). It is our opinion that medium to heavy-duty traffic loading would result in pavement failures in this area due to the relatively thin pavement thickness and very poor subgrade strength.

Three borings were used to investigate the proposed new building area back in 2017 (FSE Project No. 317176). The borings encountered an average of approximately 3.5 inches of asphalt pavement underlain by approximately 2 inches of limestone aggregate base stone. Fill was encountered beneath the asphalt and aggregate base veneer.

The fill consists of a mixture of black organic silty clay mixed with rotted wood and newspaper, shingles, glass, wire, plastic, and similar old waste materials. Some of the material appeared to have been burned. The old fill had a nasty odor. The fill was encountered to depths of from approximately 12 feet to 17 feet below existing grade. Residual soil was encountered beneath the old fill.

Based on the results of the subsurface exploration, we offer the following **abbreviated** summary of the design recommendations for the proposed new pavement (concrete and asphalt) and asphalt pavement overlay. This summary should not be considered a replacement for the detailed recommendations located within the body of this report.

RECOMMENDATION SUMMARY	
Borings	• B-1, B-2 & B-3. Borings were placed in Dec. 2017 in the new Impound Building Area.
Clearing/Grubbing/Demolition Area Of New Concrete and Asphalt Pavement	• The area where new pavement is to be placed should be stripped of existing asphalt pavement & aggregate base. The borings encountered an average of approximately 3.5 inches of asphalt and 2 inches of base stone.
Undercutting Area Of New Concrete & Asphalt Pavement	• The area of proposed new pavement should be undercut to a depth of at least 12 inches below proposed finished subgrade elevation. • Once undercut, rework and recompact the upper 6 to 8 inches of in-place material at the undercut level to a minimum of 93% standard Proctor maximum dry density. • Once reworked and recompacted, place a layer of geogrid across the area. • Once the geogrid is in-place, place 6-inches of No. 4 stone over the geogrid. • Place a layer of geotextile over the No. 4 stone. • Place a minimum of 6-inches of mineral aggregate base (TDOT 303) over the geotextile. • Any additional fill required to reach finished subgrade elevation should consist of TDOT 303 D base. • Use BX 1200 or engineer approved equal geogrid. • Use Propex Geotex 315ST or engineer approved equal geotextile. • The proposed new asphalt and mineral aggregate base pavement may be placed on the prepared subgrade.
Fill Compaction	• New Fill– Compact TDOT 303 D Base fill to a minimum of 98% Standard Proctor (ASTM D 698). • Compact No. 4 stone to a minimum of 90% ASTM D 1557.
Preparation Of Existing Asphalt Surface For New Overlay	• The surface of the existing pavement should be swept with a mechanical sweeper to remove all loose soil and gravel, as well as any aggregate loosely bonded to the existing pavement. • Once sweeping is completed, the surface of the existing asphalt should be pressure washed to remove any remaining unbonded material as well as silts and clays. • Once the surface of the existing pavement has been cleaned, a tack coat should be applied prior to placing the overlay. • The surface of the existing pavement should be observed by an engineer after cleaning is completed to ensure that any failed areas are properly repaired/stabilized and that all unbound material has been removed prior to placing the tack coat.
New Asphalt Pavement	• Medium Duty. CBR = 2 (Prepared Subgrade) • 1.5” Surface Course – TDOT 411 E • 2.5” Binder Course – 307BM • 7.0” Mineral Aggregate Base – TDOT 303 D

RECOMMENDATION SUMMARY	
New Asphalt Overlay	• Medium Duty. CBR 0.5 – 1.0 (Existing soft, wet, organic fill mixed with trash and rubble). • 4.0" Surface Course – TDOT 411 E
New Concrete Pavement	• 4" Mineral Aggregate Base & 6" 4000 psi concrete • At a minimum, the concrete should be reinforced using 4 X 4-W12 X W12 welded wire reinforcing (0.34 square inches of steel per foot of width). Alternate/equivalent reinforcing = No. 4 bars spaced at 7" on center, each way. All reinforcing should be placed at the center of the concrete. Grade 60 reinforcing steel and grade 65 welded wire.

The above summary provides an overview only and should not be used as a separate document or in place of reading the entire report, including the appendices. The summary is not a substitute for the following detailed sections of this report. A complete discussion of findings and recommendations are included in the following sections of this report.

2.0 OBJECTIVE

The purpose of our data review was to provide engineering recommendations for new asphalt pavement thickness, new concrete pavement thickness, and new asphalt overlay thickness for the new Vehicle Impoundment Building site.

3.0 SITE LOCATION AND CONDITIONS

The proposed new City of Knoxville Impound Building is to be located at 3403 Vice Mayor Jack Sharp Road in Knoxville, Tennessee. The property is located on the north side of Vice Mayor Jack Sharp Road, approximately 1,500 feet southwest of the intersection of Vice Mayor Jack Sharp Road and Prosser Road.

Topographically the site slopes downward in elevation from southeast to northwest. There are approximately 18 inches of fall across the proposed new building area.

4.0 SUBSURFACE STRATIFICATION

A total of three soil test borings (B-1 through B-3) were utilized to investigate the proposed building area. The soil test borings were placed using a CME 55 soil drilling rig mounted on an F 700 Ford Truck. Split-spoon sampling was performed through 8-inch, nominal diameter, Hollow-Stem augers as the borings were advanced.

Following is a brief summary of the soils encountered at the boring locations. Additional subsurface details may be seen in our Subsurface Exploration report dated September 13, 2017 (FSE Project No. 317176)

The following table summarizes the soil boring depths and approximate subsurface stratification.

4.1 Table I – Soil Overburden Data Summary

Boring No.	Surface Veneer	Fill	Residual	Boring Depth
B-1 EL. 975.5	0” – 4” Asphalt 4” – 6” Base Stone	6” – 12’. Very loose (very soft to soft), very moist, dark gray, and black, organic silty clay mixed with rotted wood, paper, shingles, broken glass, plastic, etc.	12’ – 15’. Stiff to very stiff, moist, reddish brown and dark reddish-brown, silty clay.	15’ Terminated
B-2 EL. 975.5	0” – 3.5” Asphalt 3.5” – 5.5” Base Stone	3.5” – 12’. Very loose (very soft to soft), very moist, dark gray, and black, organic silty clay mixed with rotted wood, paper, shingles, broken glass, plastic, etc.	12’ – 15’. Stiff to very stiff, moist, reddish brown and dark reddish-brown, silty clay.	15’ Terminated
B-3 EL. 977	0” – 3” Asphalt 3” – 4.5” Base Stone	4.5” – 17’. Very loose (very soft to soft), very moist, dark gray, and black, organic silty clay mixed with rotted wood, paper, shingles, broken glass, plastic, etc.	17’ – 20’. Stiff to very stiff, moist, reddish brown and dark reddish-brown, silty clay.	20’ Terminated

* Stratum Depths and Elevations are Approximate. Soft soils are easily molded by fingers. Very soft soils will squeeze between fingers when the fist is closed.

5.0 RECOMMENDATIONS

We offer the following engineering recommendations based on the geotechnical data gathered at the time of our subsurface exploration, and the proposed traffic data furnished by your firm.

In our opinion, the old soft, wet, trashy, organic fill encountered at the site is unsuitable for direct support of the proposed new asphalt and concrete pavement. In our opinion, some site subgrade preparation/stabilization work is needed to remove a sufficient amount of unsuitable material from the new paved areas to *bridge* over soft fill soils that will remain in place.

5.1 New Asphalt and Concrete Pavement Site Preparation

After removal of the existing asphalt and mineral aggregate base, we recommend that the proposed concrete and asphalt paved parking and drive areas be undercut down to the level of 1 foot (12-inches) below the proposed finished subgrade elevation.

Once excavated to the required depth, the upper 6 to 8 inches of the in-place soil at the undercut level should be scarified, aerated as necessary, and reworked and recompacted to a minimum of 93% Standard Proctor maximum dry density. Once reworked and recompacted, the surface of the undercut area should be smoothed and graded relatively level. Once the area has been smoothed, a layer of Tensar BX 1200 should be spread across the area. The geogrid should use a minimum lap width of 3 feet between successive roll widths. The geogrid should be hand tensioned to remove wrinkles and grabs. Tensioning should be maintained until the first lift of fill is placed over the geogrid.

Once the geogrid is in-place, a six-inch thick lift of clean, washed, ASTM C 33 size No. 4 stone should be placed across the area. The No. 4 stone should be compacted to a minimum of 90% Modified Proctor density, ASTM D 1557.

Once the No. 4 stone has been placed and compacted, it should be covered with a high modulus, woven, geotextile. We recommend Propex Geotex 315 ST be used. The geogrid should use a minimum lap width of 3 feet between successive roll widths. The geotextile should be pulled tight (hand tensioned) to remove all wrinkles and grabs. Landscape staples or similar should be used to maintain tension until the first lift of fill is placed. Once the geotextile is in place, TDOT 303D mineral aggregate base fill may be placed and compacted up to finished subgrade elevation (we estimate that approximately 6-inches of TDOT 303D base fill will be required).

The mineral aggregate base should be compacted to a minimum of 98% Standard Proctor maximum dry density, ASTM D 698.

In general, site finished grading should be performed to ensure that positive drainage is maintained away from the building and paved areas.

5.2 Existing Pavement Preparation For New Overlay

The surface of the existing pavement should be thoroughly swept with a mechanical sweeper to remove all loose soil and gravel, as well as any aggregate loosely bonded to the existing pavement.

Once sweeping is completed, the surface of the existing asphalt should be pressure washed to remove any remaining unbonded material as well as silts and clays.

The surface of the existing pavement should be observed by an engineer after cleaning is completed to ensure that any failed areas are identified and properly repaired/stabilized and that all unbound (loose) material has been removed prior to placing the tack coat.

The surface of the asphalt should be observed by the project engineer to ensure that the asphalt surface is suitable to receive the Tack Coat.

Once the surface of the existing pavement has been cleaned, a tack coat should be applied prior to placing the overlay.

5.3 New Asphalt, Concrete and Asphalt Overlay Thickness

We recommend that just before placement of the aggregate base course that the subgrade in areas of new pavement be proof rolled. Proof rolling will allow any softened and disturbed areas to be identified and properly reworked and recompacted. We do not recommend placing any of the paving courses until construction is substantially complete. Waiting until construction is substantially complete will minimize the opportunity for “heavy” construction traffic to damage pavements and shorten the pavement life.

5.4 TDOT Road and Bridge Specification

All work performed during placement of asphalt pavement, concrete pavement, mineral aggregate base, etc. should meet the specifications of the Tennessee Department of Transportation Standard Specifications for Road and Bridge Construction (TDOTSS), the latest addition, including Supplemental Specifications. Any abbreviated reference to

TDOTSS in the following paragraphs is a reference to this full specification manual (including Supplement Specifications). Any reference to a specific Section of the TDOTSS shall include by reference all other Sections or subsections referenced.

5.5 New Asphalt Pavement

Utilizing an estimated California Bearing Ratio of 2% (based on recommendations above for subgrade preparation) and assumed traffic intensities, we recommend that the asphalt pavement section consist of the following minimum compacted thicknesses of aggregate base and asphalt.

5.6 Table II – New Asphalt Pavement Section Thickness

Pavement Course	Thickness, inches
Tennessee Department of Transportation (TDOT) Specifications	**Medium Duty Pavement**
Asphalt Surface Course – TDOT 411E	1.5
Asphalt Base Course – TDOT 307BM	2.5
Aggregate Base – TDOT 303D	7.0

The aggregate base should consist of a crushed limestone meeting the requirement of the Tennessee Department of Transportation (TDOT) specification for Mineral Aggregate Base, Section 303, for Type “A” base, Class “A” aggregates, utilizing aggregate gradation “D.” The aggregate base should be compacted to a minimum of 100% of its maximum dry density as determined by the Standard Proctor test, ASTM D698.

The asphaltic base course should meet the specifications of TDOT, Section 307, Bituminous Plant Mix Base. The aggregates for the base course should meet the gradation requirements of Grading “B” modified.

The asphalt surface course should meet the specifications of TDOT 411, Asphaltic Concrete Surface, the aggregates for the mixture meeting the requirements of Grading “E.”

The asphalt surface and base courses should be compacted to a minimum of 92% of their maximum theoretical density (MTD), ASTM D2041.

The materials and placement method for the aggregate base and asphaltic surface and base courses should meet the specifications of the Tennessee Department of Transportation (TDOT) Road and Bridge Specifications. In-place density testing should

be performed during placement of the mix by a nuclear density gauge technician. Cores of asphalt should be taken initially for gauge calibration. At the Contractor option, a test strip may be installed prior to production. The test strip should be installed as per TDOT specifications.

5.7 Concrete Pavement Thickness

Site grading should be performed as outlined above. Uniformity of subgrade consistency is very important with regard to concrete pavement performance. Care should be taken to ensure that any soft areas are identified and stabilized just before the placement of the aggregate base course. The deflection of the subgrade at finished subgrade elevation under proof roll loading should be less than ½ inch. Proof rolling should be performed under the observation of a geotechnical engineer.

Utilizing an estimated soil Modulus of Subgrade Reaction K value of 50 psi/in on top of the prepared subgrade, given traffic intensities, and the *Guide for Design and Construction of Concrete Parking Lots (ACI 330R)*, we recommend that the concrete pavement consist of the following **minimum** compacted thickness of aggregate base and concrete pavement.

5.8 Table III – Concrete Pavement Section Thickness

Pavement Section	**Thickness, inches**	
Pavement Area	**Aggregate Base TDOT 303 D**	**Concrete Pavement TDOT 501***
Truck Parking & Drive	4.0	6.0

* No dowels.

The aggregate base should consist of a crushed limestone meeting the requirement of the Tennessee Department of Transportation (TDOT) specification for Mineral Aggregate Base, Section 303, for Type “A” base, Class “A” aggregates, utilizing aggregate gradation “D.” The aggregate base should be compacted to a minimum of 100% of its maximum dry density as determined by the Standard Proctor test, ASTM D698.

The concrete should meet the specifications of TDOT, Section 501 Portland Cement Concrete Pavement. The concrete should have a minimum 28-day flexural strength (modulus of rupture) of 600 psi (approximate equivalent compressive strength of 4000 psi). The concrete should be reinforced using 4 X 4-W12 X W12 welded wire reinforcing (0.34 square inches of steel per foot of width). As an equivalent alternate, the pavement may be reinforced using ASTM Grade 60, size No. 4 (1/2 inches in diameter) steel

reinforcing bars spaced at 7 inches on center, each way. The reinforcing (welded wire reinforcing or rebar) should be placed at mid-height of the concrete pavement thickness.

The amount of steel recommended is based on the *Distributed Steel Reinforcement method*, as recommended by ACI 330R-1.

The materials and placement method for the aggregate base and concrete should meet the specifications of the Tennessee Department of Transportation (TDOT) Road and Bridge Specifications.

To enhance pavement performance, we recommend minimizing the amount of moisture that can reach the soil subgrade. The following recommendations should be considered a minimum:

- Site grading performed to ensure positive drainage away from pavements.
- Install joint sealant and seal cracks immediately.

5.9 Asphalt Overlay Pavement Section Thickness

The recommended asphalt pavement overlay thickness is based on the following:

- Use of Asphalt Institute design guidelines.
- An assigned CBR value of 0.5 to 1.0 for the existing in-place old fill (subgrade improvement is not possible in areas to be overlain).
- Existing average asphalt pavement thickness of approximately 3.5 inches.
- Existing average mineral aggregate base thickness of approximately 2 inches.
- Given vehicle loading.
- Substitution ratio of 0.75 for converting existing pavement thickness to equivalent new pavement thickness.
- Substitution ratio of 1 inch of granular base for 0.3 inches of asphalt pavement.
- Asphalt Institute recommended full-depth asphalt pavement thickness of 7 inches given proposed loading and soil strength value.
- 20-year pavement design life.

Using the above procedure results in a recommended minimum pavement overlay thickness of 4 inches.

The above overlay thickness is well in excess of the originally planned 1.5 inches. The relatively thick overlay recommendation is a direct result of the relatively thin existing

pavement and very poor soil subgrade. It is likely that a 4-inch-thick overlay would negatively impact design finished pavement grades with regard to maintaining drainage across the pavement, as well as feathering the overlay into adjacent pavements.

Provided that the City is willing to accept the risk of shortened pavement life, reflective cracking up through the existing pavement, some pavement distress (bird bathing, cracking, etc.), then a thinner overlay may be placed. The thicker the overlay thickness, the lower the risk of pavement distress. We believe that by placing a minimum thickness of 1.5 inches of asphalt that there will be **low to medium risk of future pavement distress**.

Regardless of overlay thickness, we recommend that yearly pavement evaluations be made to identify areas where repairs are needed. We believe that this will assist in minimizing the severity of future pavement distress. Early maintenance would typically consist of filling cracks or placement of a pavement rejuvenator/preserver such as HA-5 High Density Mineral Bond Surface Treatment.

Subjecting the existing pavement and minimum pavement thickness overlay of 1.5 inches to heavy truck loading (heavier than the proposed dual-axle roll-back truck) could result in complete pavement failure.

Pavement Course	**Thickness, inches**
Tennessee Department of Transportation (TDOT) Specifications	**Medium Duty Pavement**
Asphalt Surface Course – TDOT 411E	4

The asphalt overlay should meet the specifications of TDOT 411, Asphaltic Concrete Surface (Hot Mix), and Bituminous Plant Mix Pavements (General) TDOT Section 407. The aggregates for the mixture should meet the aggregate gradation requirements of 903.11, Mixture Designation Grading “E.” Asphalt cement should be grade PG 64-22. The asphalt mix should contain 0.5% TDOT approved anti-strip agent.

The asphalt surface course overlay should be compacted to an average of 92% of its maximum theoretical density (MTD), ASTM D2041, with no individual test of less than 90% MTD.

In-place density testing should be performed during placement of the mix by a nuclear density gauge technician. Cores of asphalt should be taken initially for gauge calibration. At the Contractor option, a test strip may be installed prior to production. The test strip should be installed as per TDOT specifications.

6.0 ADDITIONAL RECOMMENDED WORK

We recommend that our firm be selected to provide all field and laboratory quality control construction material engineering and testing services during paving. Quality control testing and observation services are recommended to prepare the subgrade for paving, perform proofrolling, subgrade observation, compaction testing, to test asphalt, concrete, and aggregate base paving courses.

7.0 GENERAL QUALIFICATIONS

This report has been prepared for the exclusive use of The City of Knoxville. This report has been prepared in accordance with generally accepted engineering practice for specific application to the pavement thickness design elements of this project. The conclusions and recommendations contained in this report are based on the applicable standards of our practice in this geographic area at the time this report was prepared. No other warranty, expressed or implied, is made. Foundation Systems Engineering, P.C is not responsible for any claims, damages, or liability associated with any other party's interpretation of this report's data or reuse of this report's data or engineering analysis without our express written authorization. An environmental site assessment (ESA) was not performed by our firm for this project and was beyond the scope of work for this subsurface exploration report.

The analyses and recommendations submitted herein are based, in part, upon the data obtained from the borings placed in the building area in 2017. No additional borings were placed in the proposed paved areas. The nature and extent of variations between the boring may not become evident until construction. If variations appear evident, then we will re-evaluate the recommendations of this report. In the event that any change in the nature, traffic intensity, or location of the proposed new pavement is made, the conclusions and recommendations contained in this report will not be considered valid unless the changes are reviewed and conclusions modified or verified in writing.

This report should not be made a part of project plans and specifications but may be included with bidding documents for the convenience of the bidders.